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Nutrition Through the Life Cycle

8th Edition



Judith Brown

Nutrition Through the Life Cycle

8th Edition

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Preface

It is our privilege to offer you the 8th edition of *Nutrition Through the Life Cycle*. This text was initially developed, and has been revised, to address the needs of instructors teaching, and students taking, a two- to four-credit course in life-cycle nutrition. It is written at a level that assumes students have taken an introductory nutrition course. Overall, the text is intended to give instructors a tool they can productively use to enhance their teaching efforts, and to give students an engaging and rewarding educational experience they will carry with them throughout their lives and careers.

The authors of *Nutrition Through the Life Cycle* represent a group of experts with experience in clinical practice, teaching, and research related to nutrition during specific phases of the life cycle. All of us remain totally dedicated to the goals established for the text at its conception: to make the text comprehensive, logically organized, evidence-based, realistic, and relevant to the needs of instructors and students.

Chapter 1 summarizes key elements of introductory nutrition and gives students a chance to update or renew their knowledge. Students can test their knowledge of many aspects of introductory nutrition by answering the review questions listed at the end of the chapter. Coverage of the life-cycle phases begins with preconception nutrition and continues with each major phase of the life cycle through adulthood and the needs of older adults. Each of these 19 chapters was developed based on a common organizational framework that includes learning objectives, prevalence statistics, physiological principles, nutritional needs and recommendations, model programs, case studies, and recommended practices. Chapters end with a list of key points and review questions.

To meet the needs of students with the variety of career goals represented in many life-cycle nutrition courses, we include two chapters for each life-cycle phase. The first chapter for each phase covers normal nutrition topics, and the second covers nutrition-related conditions and interventions. Every chapter focuses on scientifically based information and employs up-to-date resources and references.

New to the Eighth Edition

Advances in knowledge about nutrition and health through the life cycle are expanding at a remarkably high rate. New research is taking our understanding of the roles played by healthy dietary patterns, nutrients, gene variants and nutrient–gene interactions, body fat, physical activity, and dietary supplements to new levels. You will see in this edition these emerging areas of direct relevance to nutrition addressed as well as the new tools available through the updated MyPlate.gov resources.

Chapter-by-Chapter Changes

Advances in knowledge about nutrition and health across the life cycle occur frequently and these advances have led to changes in the eighth edition of *Nutrition Through the Life Cycle*. Review questions and case studies have been revised to match the updated content.

Following are the major changes to the chapters.

Chapter 1: Nutrition Basics

- Included information on the Daily Recommended Intake (DRI) for Energy update
- Updated information and images for the Nutrition Facts Label
- Strengthened the section on food security/insecurity
- Updated information on trans fats
- Expanded the section on eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) intake
- Strengthened the section on the top chronic conditions Americans are facing
- Included updated Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) eligibility standards
- Updated Healthy People 2030 Objectives
- Updated the key elements of the *Dietary Guidelines for Americans 2020–2025*

Chapter 2: Preconception Nutrition

- Updated data and statistics throughout the chapter
- Revised folic acid supplementation levels in fortified cereals
- Updated the Healthy People 2030 Objectives related to pregnancy and childbirth

Chapter 3: Preconception Nutrition: Conditions and Interventions

- Updated data and prevalence of metabolic syndrome
- Expanded the section on metabolic healthy individuals
- Strengthened the section on gestational diabetes
- Updated gluten-free section including requirements for the nutrition facts label
- Provided new gluten-free images
- Updated prevalence of weight criteria including underweight, normal weight, overweight, and obesity

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- Added a section on dysgeusia including a definition
- Expanded the section on surrogate pregnancy and increased risk factors in this population

Chapter 4: Nutrition During Pregnancy

- Provided updated DRI for energy during pregnancy
- Updated the infant mortality rate per 1,000 births chart
- Defined the heart is the first functional organ to develop
- Expanded the section on intrauterine growth restriction (IUGR) and included fetal growth restriction as the updated terminology
- Described the impact of obesity on miscarriage risks and rates
- Updated mortality charts for both women and infants
- Revised the birthweight by gestational age chart
- Updated the rates of preterm delivery, low birthweight in the United States by ethnic backgrounds
- Updated Fish Advice image
- Updated food safety guidelines image

Chapter 5: Nutrition During Pregnancy: Conditions and Interventions

- Updated pregnancy outcomes related to pre-pregnancy weight
- Expanded the section on bariatric surgery to include more updated surgery options
- Included a section on metabolic surgery as one of the reasons for undergoing bariatric surgery
- Strengthened the section on gestational diabetes
- Provided updates and risk factors impacting pregnancy
- Strengthened the section on multifetal pregnancy
- Updated data on twin birth weights

Chapter 6: Nutrition During Lactation

- Updated breastfeeding information
- Provided updated DRI for energy during lactation
- Added a new chart on nutritional components of mammal milk
- Strengthened the section on colostrum, including updating data on composition of colostrum and mature milk
- Expanded the section on growth in the breastfed infant
- Expanded information on cholesterol in human milk
- Added key term *human milk oligosaccharide* and provided information
- Strengthened the vitamin D section
- Expanded the section on benefits to breastfeed for women
- Expanded the section on presenting the breast to the suckling infant
- Strengthened the section on infant colic
- Updated the Healthy People 2030 Objectives for breastfeeding
- Added information on the Texas 10-step program
- Expanded the section on baby-friendly hospital practices and updated the mPINC indicators associated with the ten steps for successful breastfeeding
- Added information in the Model Breastfeeding promotion programs
- Updated the Centers for Disease Control and Prevention (CDC) breastfeeding report card data information including in the rates of any and exclusive breastfeeding table

Chapter 7: Nutrition During Lactation: Conditions and Interventions

- Expanded the section on flat/inverted nipples
- Added a section on small or large nipples
- Included a new key term: *milk bleb/milk blister*
- Expanded the section on hyperlactation
- Updated the mastitis section
- Strengthened the section on Domperidone use
- Strengthened the section on use of galactagogues
- Added a section on e-cigarettes
- Expanded the section on marijuana
- Added a section on methadone
- Updated information on multiple births and neonatal intensive-care unit (NICU) stay on breastfeeding
- Added information on the impact of the COVID-19 pandemic for breastfeeding support
- Strengthened the section on colic and food intolerances
- Expanded model programs to include the Hear Her Campaign

Chapter 8: Infant Nutrition

- Updated nutrition-related baseline and target measures for infants in the U.S. Healthy People 2030 Objectives
- Updated U.S. vital statistics data related to infant birth and infant mortality
- Added information and table on responsive feeding
- Added section on *Dietary Guidelines for Americans 2020–2025* with inclusion for the first time of recommendations for infants
- Updated information on infant formula types and indications for use

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- Added new section on baby-led weaning
- Added information and table on healthy beverage consumption in early childhood from the Healthy Eating Research Expert Panel

Chapter 9: Infant Nutrition: Conditions and Interventions

- Provided updated DRI for energy for infants
- Updated information on nutrient composition of infant formulas
- Expanded section on growth in preterm infants: How to determine corrected age, how to plot measurements on the World Health Organization (WHO) growth charts, and how to assess growth

Chapter 10: Toddler and Preschooler Nutrition

- Updated Healthy People objectives with 2030 information
- Revised the estimated energy requirements and table for boys and girls with the updated DRI for energy information and calculations
- Updated charts with total kcaloric intake of carbohydrates, protein, and fat
- Provided information on new growth charts for boys and girls 2–18 years for extended body mass index (BMI)
- Updated poverty percentages including ethnic groups at risk
- Updated changes to the Childrens Food and Beverage Advertising Initiative (CFBAI)
- Expanded the section on blood levels
- Updated information on dental carries
- Strengthened the section on food security to include the impact of COVID-19
- Updated information on prevalence of overweight and obese toddlers and preschool-aged children

Chapter 11: Toddler and Preschooler Nutrition: Conditions and Interventions

- Updated information on children with special health needs
- Strengthened the section on Avoidant Restrictive Food Intake Disorder (ARFID)
- Added additional information on celiac disease
- Expanded the section on asthma and included ethnic groups at risk
- Added information on parents' self-diagnosis of food allergies in their children and implications
- Added a section on COVID-19 pandemic

Chapter 12: Child and Preadolescent Nutrition

- Updated statistics of children living in poverty and without health insurance
- Provided updated DRI for energy for children and preadolescents
- Included Healthy People 2030 Objectives related to school-aged children
- Included American Academy of Pediatrics 2020 policy statement on digital advertising to school-aged children
- Provided data about dietary intake of school-aged children related to *Dietary Guidelines for Americans 2020–2025*
- Included most recent Academy of Nutrition and Dietetics position paper on treatment of pediatric overweight and obesity
- Provided data on the relationship between soft drink consumption, BMI, and trends in sugar-sweetened beverage intake
- Updated information on nutrition education in schools
- Added information on the impact of the COVID-19 pandemic on the food security of school-aged children

Chapter 13: Child and Preadolescent Nutrition: Conditions and Interventions

- Included information from the National Survey of Children's Health, including statistics on children with special health-care needs
- Updated statistics about children in schools with specific learning disabilities, speech and language impairment, autism, developmental delay, and other medical conditions
- Expanded information on pediatric feeding disorders
- Updated information on children with attention-deficit/hyperactivity disorder (ADHD)

Chapter 14: Adolescent Nutrition

- Updated to reflect the *Dietary Guidelines for Americans 2020–2025* scientific report
- Updated information related to frequency of consuming meals and snacks
- Updated information regarding current intake of food groups

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- Updated information on school meals program regulations and best practices
- Modified illustrations and tables
- Provided updated DRI for energy during adolescence

Chapter 15: Adolescent Nutrition: Conditions and Interventions

- Updated information on prevalence and treatment of overweight and obesity among teens
- Updated information on disordered eating and eating disorders among teens
- Updated content related to screening and intervention for chronic health conditions
- Modified illustrations and tables

Chapter 16: Adult Nutrition

- Updated statistics to reflect latest available information
- Added the term *health inequity* and differentiated it from *health disparity*
- Provided updated DRI for energy for adults
- Included the impact of gender-affirming intervention on body composition for transgender persons
- Added a section on immunosenescence and the relationship of adipose tissue with immune function and inflammation
- Incorporated latest information from *Dietary Guidelines for Americans*, including concern about the contribution of beverages to excess caloric intake
- Noted newer alcohol consumption study findings that question the protective effect of moderate amounts of alcohol and raise concerns about binge drinking among younger adults
- Revised the Case Study to feature a Somali woman dealing with physical training and fasting during Ramadan

Chapter 17: Adult Nutrition: Conditions and Interventions

- Added definitions and new content for precision nutrition, metabolically healthy obesity, intermittent fasting, time-restricted eating, cardiovascular health score and primordial prevention
- Included special considerations in the screening and management of obesity and chronic conditions among transgender persons and gender minorities
- Expanded content to distinguish between metabolically heathy obesity and unhealthy obesity
- Expanded assessment of obesity to include visceral fat assessment and body composition
- Updated obesity and diabetes sections to Incorporated latest evidence-based recommendations
- Revised the bariatric surgery section and noted its broader application to metabolic disease
- Included newer emphasis on preserving health through earlier, upstream action, including consideration of the social determinants of heath, and culturally relevant, personalize intervention, with special initiatives to reach underserved and vulnerable populations
- Emphasized the role of intensive, multicomponent interventions for weight management and chronic disease intervention to bring about lifestyle change
- Noted cancer disparities experienced by persons in marginalized populations, and new initiatives to improve cancer screening, diagnosis, treatment and outcomes for these populations
- Revised Table 17.1 to contrast causes of death by decades of the adult years
- Removed the section on HIV/AIDS

Chapter 18: Nutrition and Older Adults

- Updated statistics of all the sections and their corresponding references
- Revised the life expectancy section
- Updated Healthy People (HP) to included HP 2030
- Revised the section on Dietary Recommendations for Older adults and replaced the *Dietary Guidelines* (DG) 2015–2020 with the DG 2020–2025.
- Deleted the Tufts University and University of Florida MyPlate for older adults and replaced with USDA MyPlate for different life stages
- Added the new estimated energy requirement equations released by the National Academies of Sciences, Engineering and Medicine in 2023
- Revised the fat and cholesterol section
- Updated the nutrient intake sections
- Added the *2018 Physical Activity Guidelines for Americans*
- Revised the community food and nutrition programs section
- Took out the store-to-door non-governmental small food program
- Revised and updated most of the tables and deleted illustrations 18.4 and 18.5
- Deleted Appendix A
- Provided updated DRI for energy for older adults

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Chapter 19: Nutrition and Older Adults: Conditions and Interventions

- Updated the statistics in all the sections and the corresponding references
- Revised the nutritional remedies for cardiovascular diseases section and updated the American Heart Association (AHA) guidelines for cardiovascular disease.
- Revised the section on alcohol
- Revised the section on diabetes nutrition interventions
- Updated the expert consensus on bone health
- Updated the definition of constipation
- Updated the section on cognitive impairment, dementia, and Alzheimer's disease
- Updated oseteoarthritis risk factors and potential remedies
- Deleted Tables 19.3 and 19.16

Student and Instructor Resources

MindTap: Today's leading online learning platform, MindTap for Brown's *Nutrition Through the Life Cycle*, 8th Edition, gives the instructor complete control of the course to craft a personalized, engaging learning experience that challenges students, builds confidence, and elevates performance.

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Diet & Wellness Plus: Diet & Wellness Plus is a Diet Analysis app that helps students understand how nutrition relates to their personal health goals. Track diet and activity, generate reports, and analyze the nutritional value of the food you eat, for a picture of your total health. Diet & Wellness Plus includes more than 80,000 foods with information pulled from a verified database.

Acknowledgments

It takes the combined talents and efforts of authors, editors, assistants, and the publisher to develop a new edition of a textbook and its instructional resources. We have had the pleasure of working with an ambitious and thorough group of professionals at Cengage, including Courtney Heilman, senior product manager; Paula Dohnal, senior learning designer; and Caitlin Bonaventure, content manager. Their careful and complete work on the development and implementation of this new edition is appreciated greatly. Lori Hazzard, senior project manager from MPS Limited, once again served as the textbook producer. She kept us on time and on target in an effective and thoughtful way.

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Preface

Reviewers

Many thanks to the following reviewers, whose careful reading and thoughtful comments helped enormously in shaping revisions to the 8th edition.

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May you enjoy using this text as much as the authors relish the opportunity of making it available to you.

Judith Brown *with*
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Beth L. Leonberg
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Patricia Splett
Nadine Sahyoun

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Nutrition Basics

Prepared by Judith E. Brown with Ellen Lechtenberg

Learning Objectives

After studying the materials in this chapter, you should be able to:

1.1 Understand the meaning of the nutrition concepts presented.

1.2 Read and understand the elements of nutrition labels; you will be able to understand the nutritional value of most food products.

1.3 Cite two examples of how nutrient needs change during the life cycle and how nutritional status at one stage during the life cycle can influence health status during another.

1.4 Describe the components of individual-level nutrition assessment.

1.5 Identify the basic elements of four public food and nutrition programs.

1.6 Design a healthy dietary pattern.

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Introduction

Need to freshen up your knowledge of nutrition? Or do you need to get up to speed on basic nutrition for the course? This chapter presents information about nutrition that paves the way to understanding specific needs and benefits related to nutrition by life-cycle stage.

Nutrition is an interdisciplinary science focused on the study of how foods, **nutrients**, and other food constituents affect health. The body of knowledge about nutrition is large and is growing rapidly, changing views on what constitutes the best nutrition advice. You are encouraged to stay up to date on the best nutrition advice for diet- and health-related issues.

This chapter centers on (1) the principles of the science of nutrition, (2) nutrients and other constituents of food, (3) healthy dietary patterns, (4) public food and nutrition programs, (5) nutritional assessment, and (6) nationwide priorities for improvements in the public's nutritional health.

1.1 Principles of the Science of Nutrition

Every field of science is governed by a set of principles that provides the foundation for growth in knowledge. These principles change little with time. Knowledge of the principles of nutrition, listed in Table 1.1, will serve as a springboard to greater understanding of the nutrition and health relationships explored in the chapters to come.

Nutrition Principle 1

Food is a basic need of humans.

Humans need enough food to live and the right assortment of foods for optimal health (Figure 1.1). People who can acquire and consume food to meet their needs at all times experience **food security**. They may acquire food in socially appropriate ways and legal means in the United States—such as purchasing food from grocers or markets without needing to scavenge or illegally acquire food. **Food insecurity** exists when the availability of safe, nutritious foods, or the ability to acquire them in socially appropriate ways and legal means, is limited or uncertain.[1]

nutrients Chemical substances in foods that are used by the body for growth and health.

food security Access at all times to a sufficient supply of safe, nutritious foods.

food insecurity Limited or uncertain availability of safe, nutritious foods, or the ability to acquire them in socially acceptable, legal ways.

calorie A unit of measure of the amount of energy supplied by food. Also known as the "kilocalorie" (kcal), or the "large Calorie."

Table 1.1 Principles of human nutrition

Nutrition Principle 1	Food is a basic need of humans.
Nutrition Principle 2	Foods provide energy (calories), nutrients, and other substances needed for growth and health.
Nutrition Principle 3	Health problems related to nutrition originate within cells.
Nutrition Principle 4	Poor nutrition can result from both inadequate and excessive levels of nutrient intake.
Nutrition Principle 5	Humans have adaptive mechanisms for managing fluctuations in food intake.
Nutrition Principle 6	Malnutrition can result from poor diets and from disease states, genetic factors, or combinations of these causes.
Nutrition Principle 7	Some groups of people are at higher risk of becoming inadequately nourished than others.
Nutrition Principle 8	Poor nutrition can influence the development of certain chronic diseases.
Nutrition Principle 9	Adequacy, variety, and balance are key characteristics of healthy dietary patterns.
Nutrition Principle 10	There are no "good" or "bad" foods.

It exists in 10.5 percent of households within the United States and 15.9 percent of households in Canada in 2020. In the United States, 21 percent of Black households experienced food insecurity. Indigenous Peoples in Canada had significant higher food insecurity with 30.7 percent experiencing limitations and uncertainty during this same time.[2,3]

Nutrition Principle 2

Foods provide energy (calories), nutrients, and other substances needed for growth and health.

People eat foods for many different reasons. The most compelling reason is the requirement for **calories** (energy), nutrients, and other substances supplied by foods for growth and health.

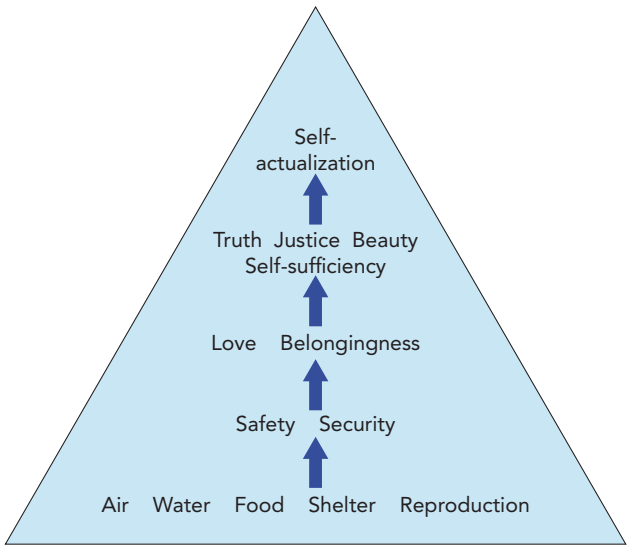


Figure 1.1 The need for food is part of Maslow's hierarchy of needs.

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A calorie is a measure of the amount of energy transferred from food to the body. Because calories are a unit of measure and not a substance actually present in food, they are not considered to be nutrients.

Nutrients are chemical substances in food that the body uses for a variety of functions that support growth, tissue maintenance and repair, and ongoing health. Essentially, every part of our body was once a nutrient consumed in food. There are six categories of nutrients (listed in Table 1.2). Each category except water consists of a number of different substances.

Essential and Nonessential Nutrients

Of the many nutrients required for growth and health, some must be provided by the diet while others can be made by the body.

Essential Nutrients Nutrients the body cannot manufacture, or generally produce in adequate amounts, are referred to as **essential nutrients**. Here, *essential* means "required in the diet." All of the following nutrients are considered essential:

- Carbohydrates
- Certain amino acids (the **essential amino acids**: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine)
- Linoleic acid and alpha-linolenic acid (essential fatty acids)
- Vitamins
- Minerals
- Water

Table 1.2 The six categories of nutrients

1.	**Carbohydrates** Chemical substances in foods that consist of a single sugar molecule or multiples of sugar molecules in various forms. Sugar and fruit, starchy vegetables, and whole grain products are good dietary sources.
2.	**Proteins** Chemical substances in foods that are made up of chains of amino acids. Animal products and dried beans are examples of protein sources.
3.	**Fats (Lipids)** Components of food that are soluble in fat but not in water. They are more properly referred to as "lipids." Most fats are composed of glycerol attached to three fatty acids. Oil, butter, sausage, and avocado are examples of rich sources of dietary fats.
4.	**Vitamins** Fourteen specific chemical substances that perform specific functions in the body. Vitamins are present in many foods and are essential components of the diet. Vegetables, fruits, and grains are good sources of vitamins.
5.	**Minerals** In the context of nutrition, minerals consist of 15 elements found in foods that perform particular functions in the body. Milk; dark, leafy vegetables; and meat are good sources of minerals.
6.	**Water** An essential component of the diet provided by food and fluid.

Nonessential Nutrients Cholesterol, creatine, and glucose are examples of nonessential nutrients. **Nonessential nutrients** are present in food and used by the body, but they do not have to be part of our diets. Many of the beneficial chemical substances in plants are not considered essential, for example, yet they play important roles in maintaining health.

Requirements for Essential Nutrients All humans require the same set of essential nutrients, but the amount of nutrients needed varies, based on:

- Age
- Body size
- Biological sex
- Genetic traits
- Growth
- Illness
- Physical activity
- Medication use
- Pregnancy and lactation

Amounts of essential nutrients required each day vary a great deal, from cups (for water) to micrograms (e.g., for folate and vitamin B_{12}).

Dietary Intake Standards

Dietary intake standards developed for the public cannot account for all of the factors that influence nutrient needs, but they do account for the major ones of age, biological sex, growth, and pregnancy and lactation. Intake standards are called Dietary Reference Intakes (DRIs).

- *Dietary Reference Intakes* (*DRIs*). This is the general term used for the nutrient intake standards for healthy people.
- *Recommended Dietary Allowances* (*RDAs*). These are levels of essential nutrient intake judged to be adequate to meet the known nutrient needs of practically all (98 percent) of healthy people while decreasing the risk of certain chronic diseases.
- *Adequate Intakes (AIs)*. These are "tentative" RDAs. AIs are based on less conclusive scientific information than are the RDAs.

essential nutrients Substances required for growth and health that cannot be produced, or produced in sufficient amounts, by the body. They must be obtained from the diet.

essential amino acids Amino acids that cannot be synthesized in adequate amounts by humans and therefore must be obtained from the diet. Also called *indispensible amino acids.*

nonessential nutrients Nutrients required for growth and health that can be produced by the body from other components of the diet.

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- *Estimated Average Requirements (EARs).* These are nutrient intake values that are estimated to meet the requirements of half the healthy individuals in a group. The EARs are used to assess adequacy of intakes of population groups.
- *Tolerable Upper Intake Levels (ULs).* These are upper limits of nutrient intake compatible with health. The ULs do not reflect desired levels of intake. Rather, they represent total, daily levels of nutrient intake from food, fortified foods, and supplements that should not be exceeded.

DRIs have been developed for most of the essential nutrients and will be updated periodically. (These are included at the end of this text.) Current DRIs were developed through a joint U.S.–Canadian effort, and the standards apply to both countries. The DRIs are levels of nutrient intake intended for use as reference values for planning and assessing diets for healthy people. They consist of the RDAs and the other categories of intake standards described in Figure 1.2. It is recommended that individuals aim for nutrient intakes that approximate the RDAs or AI levels. Additional tests are required to confirm inadequate nutrient intakes and status.[4,5]

Standards of Nutrient Intake for Nutrition Labels

The Nutrition Facts panel on packaged foods uses standard levels of nutrient intakes based on an earlier edition of recommended dietary intake levels. The levels are known as **Daily Values** (**DVs**) and are used to identify the amount of a nutrient provided in a serving of food compared to the standard level.

daily values (DVs) Scientifically agreed-upon standards for daily intakes of nutrients from the diet developed for use on nutrition labels.

The "% DV" listed on nutrition labels represents the percentages of the standards obtained from one serving of the food product. Table 1.3 lists DV standard amounts for nutrients that are mandatory or voluntary components of nutrition labels. Additional information on nutrition labeling is presented later in this chapter.

Table 1.3 Daily Values (DVs) for nutrition labeling based on intakes of 2000 calories per day in adults and children aged 4 years and above

Mandatory Components of the Nutrition Label	
Food Component	**Daily Value (DV)**
Total fat	78 g[a]
Saturated fat	20 g
Cholesterol	300 mg[a]
Sodium	2,300 mg
Total carbohydrate	275 g
Dietary fiber	28 g
Protein	50 g
Vitamin D	20 mcg
Calcium	1,300 mg
Iron	18 mg

[a]g = grams; mg = milligrams; IU = International Units

Carbohydrates

Carbohydrates are used by the body mainly as a source of readily available energy. They consist of the simple sugars (monosaccharides and disaccharides), complex carbohydrates (the polysaccharides), most dietary sources of fiber, and alcohol sugars. Alcohol (ethanol) is closely related chemically to carbohydrates and is usually considered to be part of this nutrient category. Figure 1.3 shows the similarity in the chemical structure of basic carbohydrate units. The most basic forms of carbohydrates are single molecules called monosaccharides.

Glucose (also called "blood sugar" and "dextrose"), fructose ("fruit sugar"), and galactose are the most common monosaccharides. Molecules containing two monosaccharides are called disaccharides. The most common disaccharides are:

- Sucrose (glucose + fructose, or common table sugar)
- Maltose (glucose + glucose, or malt sugar)
- Lactose (glucose + galactose, or milk sugar)

Complex carbohydrates (also called polysaccharides) are considered "complex"

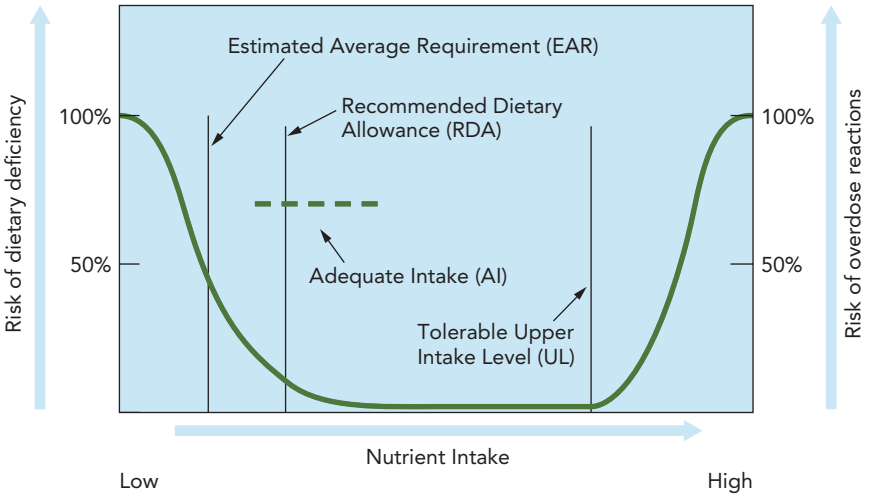


Figure 1.2 Theoretical framework, terms, and abbreviations used in the Dietary Reference Intakes.

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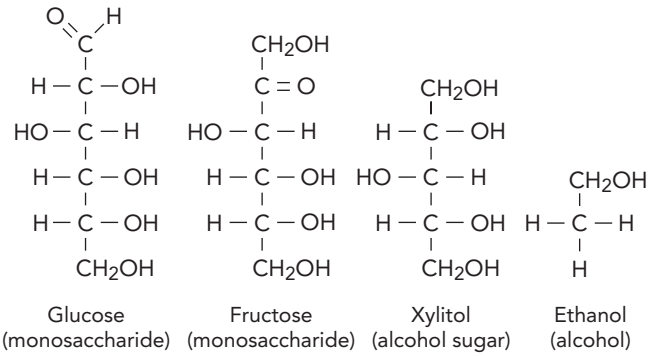


Figure 1.3 Chemical structures of some simple carbohydrates.

because they have more elaborate chemical structures than the simple sugars. They include:

- Starches (the plant form of stored carbohydrate)
- Glycogen (the animal form of stored carbohydrate)
- Most types of fiber

Each type of simple and complex carbohydrate, except fiber, provides 4 calories per gram. Dietary fiber supplies 2 calories per gram on average, even though fiber cannot be broken down by human digestive enzymes. Bacteria in the large intestine can digest some types of dietary fiber, however. These bacteria excrete fatty acids as a waste product of fiber digestion. The fatty acids are absorbed and used as a source of energy. The total contribution of fiber to our energy intake is modest (around 50 calories), and supplying energy is not a major function of fiber.[6,7] The main function of fiber is to provide "bulk" for normal elimination. It has other beneficial properties, however. High-fiber diets reduce the rate of glucose absorption (a benefit for people with diabetes) and may help prevent cardiovascular disease and obesity.[8]

Alcohol sugars (nonalcoholic in the beverage sense) are like simple sugars, except they include a chemical component of alcohol. Xylitol, mannitol, and sorbitol are common forms of alcohol sugars. Some are very sweet, and only small amounts are needed to sweeten commercial beverages, gums, yogurt, and other products. Unlike the simple sugars, alcohol sugars do not promote tooth decay.

Alcohol (consumed as ethanol) is considered to be part of the carbohydrate family because its chemical structure is similar to that of glucose. It is a product of the fermentation of sugar with yeast. With 7 calories per gram, alcohol has more calories per gram than do other carbohydrates.

Glycemic Index of Carbohydrates and Carbohydrates in Foods In the not-too-distant past, it was assumed that "a carbohydrate is a carbohydrate is a carbohydrate." If all types of carbohydrates had the same effect on blood glucose levels and health, then it didn't matter what type was consumed. As is the case with many untested assumptions, this one fell by the wayside. It is now known that some types of simple and complex carbohydrates in foods elevate blood glucose levels more than do others. Such differences are particularly important to people with disorders such as **insulin resistance** and **type 2 diabetes**.[9]

Carbohydrates and carbohydrate-containing foods are now being classified by the extent to which they increase blood glucose levels. This classification system is called the **glycemic index**. Carbohydrates that are digested and absorbed quickly have a high glycemic index and raise blood glucose levels to a higher extent than do those with lower glycemic index values (Table 1.4).[11,12]

Recommended Intake Level Recommended intake of carbohydrates is based on their contribution to total energy intake. It is recommended that 45 to 65 percent of calories come from carbohydrates. Added sugar should constitute no more than 10 percent of total caloric intake. It is recommended that adult females consume between 21 and 28 g, and males 30 to 38 g of total dietary fiber daily.[10]

Food Sources of Carbohydrates Carbohydrates are widely distributed in plant foods, while milk is the only important animal source of carbohydrates (lactose). Table 1.5 lists selected food sources by type of carbohydrate.

Protein

Protein in foods provides the body with **amino acids** used to build and maintain protein-based components of the body such as muscle, bone, enzymes, and red blood cells. The body can also use protein as a source of energy—it provides 4 calories per gram. However, this is not a primary function of protein. Of the common types of amino acids, nine must be provided by the diet and are classified as essential amino acids. Amino acids that the body needs but can manufacture from other amino acids and components of the diet are classified as **nonessential amino acids**.

insulin resistance A condition in which cell membranes have a reduced sensitivity to insulin so that more insulin than normal is required to transport a given amount of glucose into cells.

type 2 diabetes A disease characterized by high blood glucose levels due to the body's inability to use insulin normally, to produce enough insulin, or both.

glycemic index A measure of the extent to which blood glucose levels are raised by consumption of an amount of food that contains 50 g of carbohydrate compared to 50 g of glucose. A portion of white bread containing 50 g of carbohydrate is sometimes used for comparison instead of 50 g of glucose.

amino acids The "building blocks" of protein. Unlike carbohydrates and fats, amino acids contain nitrogen.

nonessential amino acids Amino acids that can be readily produced by humans from components of the diet. Also referred to as *dispensable amino acids*.

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Table 1.4 Glycemic Index (GI) of selected foods[11,12]

High GI	(70 and higher)	Medium GI	(56–69)	Low GI	(55 or lower)
Glucose	100	Breadfruit	69	Honey	55
French bread	95	Fruit Loops	69	Oatmeal	54
Scone	92	Orange soda	68	Corn	53
Sticky rice	87	Pita bread	68	Cracked wheat bread	53
Broken rice	86	Sucrose	68	Orange juice	52
Potato, baked	85	Taco shells	68	Banana	52
Potato, instant mashed	85	Croissant	67	Mango	51
Special K, rice	84	Angel food cake	67	Potato, boiled	50
Corn Chex	83	Fruit punch	67	Corn tortilla	49
Pretzel	83	Cherries	66	Green peas	48
Rice Krispies	82	Cream of Wheat	66	Pasta	48
Cornflakes	81	Brown rice	66	Carrots, raw	47
Corn Pops	80	Couscous	65	Lactose	46
Gatorade	78	Quaker Quick Oats	65	Milk chocolate	43
Jelly beans	78	Raisins	64	All-Bran	42
Cocoa pops	77	Chapati	62	Orange	42
Doughnut, cake	76	French bread with butter and jam	62	Peach	42
Waffle, frozen	76	Raisin Bran	61	Apple juice	40
Doughnuts	75	Sweet potato	61	Apple	38
French fries	75	Bran muffin	60	Pear	38
Grape Nuts	75	Just Right cereal	60	Tomato juice	38
Shredded Wheat	75	Blueberry muffin	59	Yam	37
White rice	75	Mini Wheats	59	Yogurt	31
Cheerios	74	Coca-Cola	58	Flour tortilla	30
Popcorn	72	Power Bar	56	Dried beans	25
Watermelon	72	Special K	56	Grapefruit	25
Carrots, diced, cooked	70			Milk	25
Wheat bread	70			Fructose	19
White bread	70			Pinto beans	14
				Hummus	6

Food sources of protein (Table 1.6) differ in quality based on the types and amounts of amino acids they contain. Foods of high protein quality include a balanced assortment of all of the essential amino acids. Protein from milk, cheese, meat, eggs, and other animal products is considered high quality. Plant sources of protein, with the exception of soybeans for adults, do not provide all nine essential amino acids in amounts needed to support growth in children and tissue maintenance. Combinations of plant foods, such as grains or seeds with dried beans, however, yield high-quality protein. The variety of amino acids found in these foods complement each other, thus providing a source of high-quality protein.

kwashiorkor A severe form of protein-energy malnutrition in young children. It is characterized by swelling, fatty liver, susceptibility to infection, profound apathy, and poor appetite. The cause of kwashiorkor is unclear.

Recommended Protein Intake DRIs for protein are shown on the inside front cover of this text. In general, proteins should contribute 10 to 35 percent of total energy intake.[10] Protein deficiency, although rare in economically developed countries, leads to loss of muscle tissue, growth failure, weakness, reduced resistance to disease, and kidney and heart problems. It contributes to the development of a severe form of protein-energy malnutrition in young children known as **kwashiorkor**.

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Table 1.5 Food sources of carbohydrates

A. Simple Sugars (Mono- and Disaccharides)

The Simple Sugar Content of Some Common Foods

	Portion Size	Grams of Carbohydrates		Portion Size	Grams of Carbohydrates[a]
Sweeteners			**Beverages**		
Corn syrup	1 tsp	5	Fruit drinks	1 cup	29
Honey	1 tsp	6	Soft drinks	12 oz	38
Maple syrup	1 tsp	4	Skim milk	1 cup	12
Table sugar	1 tsp	4	Whole milk	1 cup	11
Fruits			**Candy**		
Apple	1 medium	16	Gumdrops	1 oz	25
Peach	1 medium	8	Hard candy	1 oz	28
Watermelon	1 wedge (4″ × 8″)	25	Caramels	1 oz	21
Orange	1 medium	14	Fudge	1 oz	21
Banana	1 medium	21	Milk chocolate	1 oz	16
Vegetables			**Breakfast cereals**		
Broccoli	½ cup	2	Apple Jacks	1 oz	13
Corn	½ cup	3	Raisin Jacks	1 oz	19
Potato	1 cup	1	Cheerios	1 oz	14

B. Complex Carbohydrates (Starches)

Complex

	Portion Size	Grams of Carbohydrates		Portion Size	Grams of Carbohydrates
Grain and grain products			**Dried beans (cooked)**		
Rice (white), cooked	½ cup	21	Lima beans	½ cup	11
Pasta, cooked	½ cup	15	White beans	½ cup	13
Cornflakes	1 cup	11	Kidney beans	½ cup	12
Oatmeal, cooked	½ cup	12	**Vegetables**		
Cheerios	1 cup	11	Potato	1 medium	30
Whole wheat bread	1 slice	7	Corn	½ cup	10
			Broccoli	½ cup	2

C. Dietary Fiber

	Portion Size	Grams of Fiber		Portion Size	Grams of Fiber
Grain and grain products			**Fruits**		
Bran Buds	½ cup	12.0	Raspberries	1 cup	8.0
All Bran	½ cup	11.0	Avocado	½ medium	7.0
Raisin Bran	1 cup	7.0	Mango	1 medium	4.0
Granola (homemade)	½ cup	6.0	Pear (with skin)	1 medium	4.0
Bran Flakes	¾ cup	5.0	Apple (with skin)	1 medium	3.3
Oatmeal	1 cup	4.0	Banana	6″ long	3.1
Spaghetti noodles	1 cup	4.0	Orange (no peel)	1 medium	3.0
Shredded Wheat	1 biscuit	2.7	Peach (with skin)	1 medium	2.3
Whole wheat bread	1 slice	2.0	Strawberries	10 medium	2.1
Bran (dry; wheat, oat)	2 Tbsp	2.0			

(continued)

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Table 1.5 Food sources of carbohydrates (continued)

C. Dietary Fiber (continued)					
	Portion Size	**Grams of Fiber**		**Portion Size**	**Grams of Fiber**
Vegetables			**Dried beans (cooked)**		
Lima beans	½ cup	6.6	Pinto beans	½ cup	10.0
Green peas	½ cup	4.4	Peas, split	½ cup	8.2
Potato (with skin)	1 medium	3.5	Black beans (turtle beans)	½ cup	8.0
Brussels sprouts	½ cup	3.0	Lentils	½ cup	7.8
Broccoli	½ cup	2.8	Kidney or navy beans	½ cup	6.9
Carrots	½ cup	2.8	Black-eyed peas	½ cup	5.3
Green beans	½ cup	2.7	**Fast foods**		
Collard greens	½ cup	2.7	Big Mac	1	3
Cauliflower	½ cup	2.5	French fries	1 regular serving	3
Corn	½ cup	2.0	Whopper	1	3
Nuts			Cheeseburger	1	2
Almonds	¼ cup	4.5	Taco	1	2
Peanuts	¼ cup	3.3	Chicken sandwich	2	1
Peanut butter	2 Tbsp	2.3	Egg McMuffin	1	1
			Fried chicken, drumstick	1	1

[a]4 grams sucrose = 1 teaspoon.

Fats (Lipids)

Fats in food share the property of being soluble in fats but not in water. They are actually a subcategory of *lipids*, but this category of macronutrient is referred to as fat in the DRIs.[10] Lipids include fats, oils, and related compounds such as cholesterol. Fats are generally solid at room temperature, whereas oils are usually liquid. Fats and oils are made up of various types of triglycerides (triacylglycerols), which consist of three **fatty acids** attached to **glycerol** (Figure 1.4). The number of carbons contained in the fatty acid component of triglycerides varies from 8 to 22.

Fats and oils are a concentrated source of energy, providing 9 calories per gram. Fats perform a number of important functions in the body. They are needed for cholesterol and sex-hormone synthesis, components of cell membranes, vehicles for carrying certain vitamins that are soluble in fats only, and suppliers of the **essential fatty acids** required for growth and health.

Essential Fatty Acids There are two essential fatty acids: linoleic acid and alpha-linolenic acid. Because these fatty acids are essential, they must be supplied in the diet.

fatty acids The fat-soluble components of fats in foods.

glycerol A component of fats that is soluble in water. It is converted to glucose in the body.

essential fatty acids Components of fat that are a required part of the diet (i.e., linoleic and alpha-linolenic acids). Both contain unsaturated fatty acids.

The central nervous system (CNS) is particularly rich in derivatives of these two fatty acids. They are found in phospholipids, which—along with cholesterol—are the

Table 1.6 Food sources of protein

	Portion Size	**Grams of Protein**
Meats		
Beef, lean	3 oz	26
Tuna, in water	3 oz	24
Hamburger, lean	3 oz	24
Chicken, no skin	3 oz	24
Lamb	3 oz	22
Pork chop, lean	3 oz	20
Haddock, broiled	3 oz	19
Egg	1 med	6
Dairy Products		
Cottage cheese, low fat	½ cup	14
Yogurt, low fat	1 cup	13
Milk, skim	1 cup	9
Milk, whole	1 cup	8
Swiss cheese	1 oz	8
Cheddar cheese	1 oz	7
Grain Products		
Oatmeal, cooked	½ cup	4
Pasta, cooked	½ cup	4
Bread	1 slice	2
Rice, white or brown	½ cup	2

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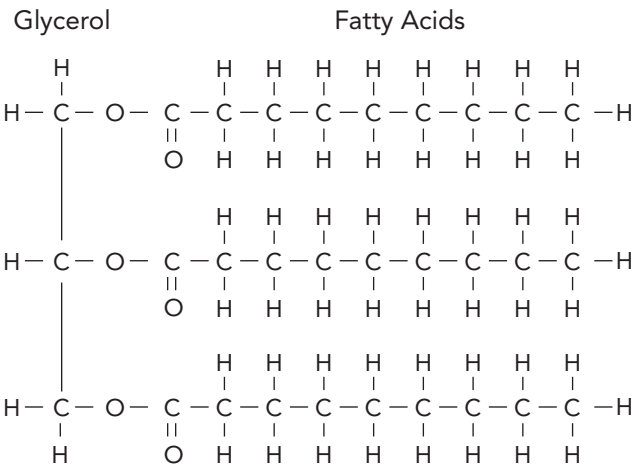


Figure 1.4 Basic structure of a triglyceride.

primary lipids in the brain and other nervous system tissue. Biologically active derivatives of essential fatty acids include **prostaglandins**, **thromboxanes**, and **prostacyclins**.

Linoleic Acid Linoleic acid is the parent of the omega-6 (or n-6) fatty acid family. One of the major derivatives of linoleic acid is arachidonic acid. Arachidonic acid serves as a primary structural component of the central nervous system. Most vegetable oils and meats, as well as human milk, are good sources of linoleic acid. American diets tend to provide sufficient to excessive levels of linoleic acid, and considerable amounts are stored in body fat.

Alpha-Linolenic Acid Alpha-linolenic acid is the parent of the omega-3 (n-3) fatty acid family. It is present in many types of dark-green vegetables, vegetable oils, and flaxseed. Derivatives of this essential fatty acid include eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Relatively small amounts of EPA and DHA are produced in the body from alpha-linolenic acid because the conversion is low.[10] EPA and DHA also enter the body through intake of fatty, cold-water fish, shellfish, and human milk. Regular consumption of fish (two or more servings per week) reduces chronic inflammation and the risk of heart disease and sudden cardiac death.[13] DHA is found in large amounts in the central nervous system, the retina of the eye, and the testes. The body stores only small amounts of alpha-linolenic acid, EPA, and DHA.[14,15] Recommended daily intakes for EPA and DHA have not been set, however, adequate intakes for different age groups have been published. On average, adults residing in the United States and Canada consume around 100 mg of EPA plus DHA daily, far short of the estimated need of 200 to 500 mg daily.[16] The National Health and Examination Study from 2003–2014 published in 2019 documented increasing intake of EPA, DHA, and EPA+DHA with age. Despite this increase, the authors noted EPA and DHA intake was inadequate in all age groups in the study regardless of gender, age, or pregnancy status.[17]

Saturated and Unsaturated Fats Fats (lipids) come in two basic types: **saturated** and **unsaturated**. Whether a fat is saturated or not depends on whether it has one or more double bonds between carbon atoms in one or more of its fatty acid components. If one double bond is present in one or more of the fatty acids, the fat is considered **monounsaturated**; if two or more are present, the fat is **polyunsaturated**.

Some unsaturated fatty acids are highly unsaturated. Alpha-linolenic acid, for example, contains three double bonds, arachidonic acid four, EPA five, and DHA six. These fatty acids are less stable than fatty acids with fewer double bonds, because double bonds between atoms are weaker than single bonds.

Saturated fats contain no double bonds between carbons and tend to be solid at room temperature. Animal products such as butter, cheese, and meats and two plant oils (coconut and palm) are rich sources of saturated fats. Fat we consume in our diets, whether it contains primarily saturated or unsaturated fatty acids, is generally in the triglyceride (or triacylglyceride) form.

Although most foods contain both saturated and unsaturated fats, animal foods tend to contain more saturated and less unsaturated fat than plant foods. Saturated fatty acids tend to increase blood levels of LDL cholesterol (the lipoprotein that is associated with heart-disease risk when present in high levels), whereas unsaturated fatty acids tend to decrease LDL cholesterol levels.[3,18]

prostaglandins A group of physiologically active substances derived from the essential fatty acids. They are present in many tissues and perform such functions as the constriction or dilation of blood vessels and stimulation of smooth muscles and the uterus.

thromboxanes Biologically active substances produced in platelets that increase platelet aggregation (and therefore promote blood clotting), constrict blood vessels, and increase blood pressure.

prostacyclins Biologically active substances produced by blood vessel walls that inhibit platelet aggregation (and therefore blood clotting), dilate blood vessels, and reduce blood pressure.

saturated fats Fats in which adjacent carbons in the fatty acid component are linked by single bonds only (e.g., –C–C–C–C–).

unsaturated fats Fats in which adjacent carbons in one or more fatty acids are linked by one or more double bonds (e.g., –C–C=C–C=C–).

monounsaturated fats Fats in which only one pair of adjacent carbons in one or more of its fatty acids is linked by a double bond (e.g., –C–C=C–C–).

polyunsaturated fats Fats in which more than one pair of adjacent carbons in one or more of its fatty acids are linked by two or more double bonds (e.g., –C–C=C–C=C–).

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- ***Hydrogenation and Trans Fats*** Oils can be made solid by adding hydrogen to the double bonds of their unsaturated fatty acids. This process, called hydrogenation, makes some of the fatty acids in oils saturated and enhances storage life and baking qualities. Hydrogenation may alter the molecular structure of the fatty acids; however, changing the naturally occurring *cis* structure to the *trans* form. *Trans*-fatty acids raise blood LDL-cholesterol levels to a greater extent than do saturated fatty acids. They are naturally present in dairy products and meats, but the primary dietary sources are products made from hydrogenated fats. Due to nutrition labeling requirements and public uproar, the ***trans* fat** content of bakery products, chips, fast foods, and other products made with hydrogenated fats has decreased substantially. In 2015, the Food and Drug Administration (FDA) banned artificial *trans* fats effective June of 2018. An extension was made for products in production prior to the ruling to be compliant by January 1, 2020.[19] As of December 2021, the United Nations reported 40 countries had best practice policies to eliminate *trans* fats.[20]

Cholesterol Dietary **cholesterol** is a fatlike, clear liquid substance primarily found in lean and fat components of animal products. Cholesterol is a component of all animal cell membranes, the brain, and the nerves. It is the precursor of estrogen, testosterone, and vitamin D, which is manufactured in the skin upon exposure to sunlight. The body generally produces only one-third of the cholesterol our bodies use because more than sufficient amounts of cholesterol are provided in most people's diet. The extent to which dietary cholesterol intake modifies blood cholesterol level appears to vary a good deal based on genetic tendencies.[18,21] Leading sources of dietary cholesterol are egg yolks, meat, milk and milk products, and fats such as butter.

Recommended Intake of Fats Scientific evidence and opinions related to the effects of fat on health have changed substantially in recent years—and so have recommendations for fat intake. In the past, it was recommended that individuals residing in the United States aim for diets providing less than 30 percent of total calories from fat.

***trans* fat** A type of unsaturated fat present in hydrogenated oils, margarine, shortenings, pastries, and some cooking oils that increase the risk of heart disease. Fats containing fatty acids in the *trans* versus the more common *cis* form are generally referred to as *trans* fat.

cholesterol A fat-soluble, colorless liquid primarily found in animal products.

dietary pattern The quantities, proportions, variety, or combination of different foods, drinks, and nutrients in diets, and the frequency with which they are habitually consumed.

coenzymes Chemical substances that activate enzymes.

Concerns that high-fat diets encourage the development of obesity have been eased by studies demonstrating that excessive caloric intakes—and not diets high in fat—are related to weight gain. Current advice indicates that dietary fat intake should be within the range of 20 to 35 percent of total calories with approximately 10 percent or less from saturated fats. Average intake of fat among adults in the United States is 33 percent of total calories.[13]

There is no recommended level of cholesterol intake, because there is no evidence that cholesterol is required in the diet. The body, under normal functioning, can produce enough cholesterol, and individuals should not develop a cholesterol deficiency disease if it is not consumed.

Overall, it is recommended that **dietary patterns** emphasize food sources of polyunsaturated fats, that intake of *trans* fats should be as low as possible with elimination of artificial *trans* fats, and that consumption of EPA and DHA should be increased by eating fish at least twice a week. Reduced intake of foods high in saturated fat intake is also recommended.[13]

Food Sources of Fat The fat content of many foods can be identified by reading the nutrition information labels on food packages. The amount of total fat, saturated fat, *trans* fat, and cholesterol in a serving of food is listed on the label. Table 1.7 lists the total fat, saturated fat, unsaturated fat, cholesterol, and omega-3 fatty acid contents (EPA and DHA) of selected foods.

Vitamins

Vitamins are chemical substances in foods that perform specific functions in the body. Fourteen have been discovered so far. They are classified as either fat soluble or water soluble (Table 1.8).

The B-complex vitamins and vitamin C are soluble in water and found dissolved in water in foods. The fat-soluble vitamins consist of vitamins A, D, E, and K and are present in the fat portions of foods. (To remember the fat-soluble vitamins, think of "DEKA" for vitamins D, E, K, and A.) Only these chemical substances are truly vitamins. Substances such as coenzyme Q_{10}, inositol, provitamin B_5 complex, and pangamic acid (vitamin B_{15}) may be called vitamins, but they are not. Except for vitamin B_{12}, water-soluble vitamin stores in the body are limited and run out within a few weeks to a few months after intake becomes inadequate. Fat-soluble vitamins are stored in the body's fat tissues and the liver. These stores can be sizable and last from months to years when intake is low.

Excessive consumption of the fat-soluble vitamins from supplements, especially of vitamins A and D, produces various symptoms of toxicity. High intake of the water-soluble vitamins from supplements can also produce adverse health effects. Toxicity symptoms from water-soluble vitamins, however, tend to last a shorter time and are more quickly remedied. Vitamin overdoses are very rarely related to food intake.

Vitamins do not provide energy or serve as structural components of the body. Some play critical roles as **coenzymes** in chemical changes that take place in the body, known as

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Table 1.7 Food sources of fats

A. Total Fat

	Portion Size	Grams of Total Fat		Portion Size	Grams of Total Fat
Fats and Oils			Milk, 2%	1 cup	5.0
Mayonnaise	1 Tbsp	11.0	Hamburger, 21% fat	3 oz	15.0
Ranch dressing	1 Tbsp	6.0	Hamburger, 16% fat	3 oz	13.5
Vegetable oils	1 tsp	4.7	Steak, rib-eye	3 oz	9.9
Butter	1 tsp	4.0	Bacon	3 strips	9.0
Margarine	1 tsp	4.0	Steak, round	3 oz	5.2
Meats, Fish			Chicken, baked, no skin	3 oz	4.0
Sausage	4 links	18.0	Flounder, baked	3 oz	1.0
Hot dog	2 oz	17.0	Shrimp, boiled	3 oz	1.0
Fast Foods			Milk, 1%	1 cup	2.9
Whopper	8.9 oz	32.0	Milk, skim	1 cup	0.4
Big Mac	6.6 oz	31.4	Yogurt, frozen	1 cup	0.3
Quarter Pounder with Cheese	6.8 oz	28.6	**Other Foods**		
Veggie pita	1	17.0	Avocado	½	15.0
Subway meatball sandwich	1	16.0	Almonds	1 oz	15.0
Subway turkey sandwich	1	4.0	Cashews	1 oz	13.2
Milk and Milk Products			French fries	14	10.0
Cheddar cheese	1 oz	9.5	Taco chips	1 oz (10 chips)	10.0
Milk, whole	1 cup	8.5	Potato chips	1 oz (14 chips)	7.0
American cheese	1 oz	6.0	Peanut butter	1 Tbsp	6.1
Cottage cheese, regular	½ cup	5.1	Egg	1	6.0

B. Saturated Fats

	Portion Size	Grams of Saturated Fat		Portion Size	Grams of Saturated Fat
Fats and Oils			Hot dog	1	4.9
Margarine	1 tsp	2.9	Chicken, fried, with skin	3 oz	3.8
Butter	1 tsp	2.4	Salami	3 oz	3.6
Salad dressing, ranch	1 Tbsp	1.2	Haddock, breaded, fried	3 oz	3.0
Peanut oil	1 tsp	0.9	Rabbit	3 oz	3.0
Olive oil	1 tsp	0.7	Pork chop, lean	3 oz	2.7
Salad dressing, thousand island	1 Tbsp	0.5	Steak, round, lean	3 oz	2.0
Canola oil	1 tsp	0.3	Turkey, roasted	3 oz	2.0
Milk and Milk Products			Chicken, baked, no skin	3 oz	1.7
Cheddar cheese	1 oz	5.9	Prime rib, lean	3 oz	1.3
American cheese	1 oz	5.5	Venison	3 oz	1.1
Milk, whole	1 cup	5.1	Tuna, in water	3 oz	0.4
Cottage cheese, regular	½ cup	3.0	**Fast Foods**		
Milk, 2%	1 cup	2.9	Croissant w/egg, bacon, & cheese	1	16.0
Milk, 1%	1 cup	1.5	Sausage croissant	1	16.0
Milk, skim	1 cup	0.3	Whopper	1	11.0
Meats, Fish			Cheeseburger	1	9.0
Hamburger, 21% fat	3 oz	6.7	Bac'n Cheddar Deluxe	1	8.7
Sausage, links	4	5.6			

(continued)

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Table 1.7 Food sources of fats (continued)

B. Saturated Fats (continued)

	Portion Size	Grams of Saturated Fat		Portion Size	Grams of Saturated Fat
Taco, regular	1	4.0	Peanuts, dry-roasted	1 oz	1.9
Chicken breast sandwich	1	3.0	Sunflower seeds	1 oz	1.6
Nuts and Seeds					
Macadamia nuts	1 oz	3.2			

C. Unsaturated Fats

	Portion Size	Grams of Unsaturated Fat		Portion Size	Grams of Unsaturated Fat
Fats and Oils			Haddock, breaded, fried	3 oz	6.5
Canola oil	1 tsp	4.1	Chicken, baked, no skin	3 oz	6.0
Vegetable oils	1 tsp	3.6	Pork chop, lean	3 oz	5.3
Margarine	1 tsp	2.9	Turkey, roasted	3 oz	4.5
Butter	1 tsp	1.3	Tuna, in water	3 oz	0.7
Milk and Milk Products			Egg	1	5.0
Cottage cheese, regular	½ cup	3.0	**Nuts and Seeds**		
Cheddar cheese	1 oz	2.9	Sunflower seeds	1 oz	16.6
American cheese	1 oz	2.8	Almonds	1 oz	12.6
Milk, whole	1 cup	2.8	Peanuts	1 oz	11.3
Meats, Fish			Cashews	1 oz	10.2
Hamburger, 21% fat	3 oz	10.9			

D. Cholesterol

	Portion Size	Milligrams Cholesterol		Portion Size	Milligrams Cholesterol
Fats and Oils			Ostrich, ground	3 oz	63
Butter	1 tsp	10.3	Pork chop, lean	3 oz	60
Vegetable oils, margarine	1 tsp	0	Hamburger, 10% fat	3 oz	60
Meats, Fish			Venison	3 oz	48
Brain	3 oz	1476	Wild pig	3 oz	33
Liver	3 oz	470	Goat, roasted	3 oz	32
Egg	1	186	Tuna, in water	3 oz	25
Veal	3 oz	128	**Milk and Milk Products**		
Shrimp	3 oz	107	Ice cream, regular	1 cup	56
Prime rib	3 oz	80	Milk, whole	1 cup	34
Chicken, baked, no skin	3 oz	75	Milk, 2%	1 cup	22
Salmon, broiled	3 oz	74	Yogurt, low fat	1 cup	17
Turkey, baked, no skin	3 oz	65	Milk, 1%	1 cup	14
Hamburger, 20% fat	3 oz	64	Milk, skim	1 cup	7

E. Omega-3 (N-3) Fatty Acids

	Portion Size	Milligrams EPA + DHA		Portion Size	Milligrams EPA + DHA
Fish and Seafood			Anchovies	3 oz	1747
Fish oil	1 tsp	2796	Herring	3 oz	1712
Shad	3 oz	2046	Salmon, wild	3 oz	1564
Salmon, farmed	3 oz	1825	Whitefish	3 oz	1370

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Table 1.7 Food sources of fats (continued)

E. Omega-3 (N-3) Fatty Acids (continued)					
	Portion Size	Milligrams EPA + DHA		Portion Size	Milligrams EPA + DHA
Mackerel	3 oz	1023	Catfish, wild	3 oz	201
Sardines	3 oz	840	Crawfish	3 oz	187
Whiting	3 oz	440	Sheepshead	3 oz	162
Flounder	3 oz	426	Tuna, light, and in oil	3 oz	109
Trout, freshwater	3 oz	420	Lobster	3 oz	71
Oysters	3 oz	375	Egg yolk	1	40
Snapper	3 oz	273	DHA-fortified egg	1	150
Shrimp	3 oz	268	Human milk	4 oz	126
Clams	3 oz	241	DHA-fortified beverages	4 oz	32
Haddock	3 oz	202			

*Mercury content< 0.2 ppm as given in *Mercury levels in commercial fish and shellfish*, (1990–2012), current February 25, 2022. U. S. Food and Drug Association. Available at www.fda.gov.

metabolism. Vitamin A is needed to replace the cells that line the mouth and esophagus, thiamin is needed for maintenance of normal appetite, and riboflavin and folate are needed for the synthesis of body proteins. Other vitamins (vitamins C and E, and beta-carotene—a precursor of vitamin A) act as **antioxidants** and perform other functions. By preventing or repairing damage to cells due to oxidation, these vitamins help maintain body tissues and prevent disease. Primary functions, consequences of deficiency and overdose, primary food sources, and comments about each vitamin are listed in Table 1.9.

Recommended Intake of Vitamins

Recommendations for levels of intake of vitamins are presented in the tables on the inside front covers of this text. Note that Tolerable Upper Levels of Intake (ULs) for many vitamins are also given; they represent levels of intake that should not be exceeded. Table 1.10 lists food sources of each vitamin.

Phytochemicals

There are many substances in foods in addition to nutrients that affect health. Some foods contain naturally occurring toxins, such as poison in puffer fish and solanine in green sections near the skin of some potatoes. Consuming the poison in puffer fish can be lethal; large doses of solanine can interfere with nerve impulses. Some plant pigments, hormones, and other naturally occurring substances that protect plants from insects, oxidization, and other damaging exposures also appear to benefit human health. These substances in plants are referred to as **phytochemicals**, and knowledge about their effects on human health is advancing rapidly. Many of the phytochemicals that benefit health are pigments that act as antioxidants in the human body.[21] Table 1.11 shows a list of the good food sources of antioxidants. Notice that most of the foods listed are colorful.

Consumption of foods rich in specific pigments and other phytochemicals, rather than consumption of isolated phytochemicals, may help prevent certain types of cancer, cataracts, type 2 diabetes, hypertension, infections, and heart disease. High intakes of certain phytochemicals from vegetables, fruits, nuts, seeds, and whole-grain products may partially account for lower rates of heart disease and cancer observed in people with high intakes of these foods.[22,23]

Table 1.8 Vitamin solubility

Water-Soluble Vitamins	Fat-Soluble Vitamins
B-complex vitamins Thiamin (B_1) Riboflavin (B_2) Niacin (B_3) Vitamin B_6 Folate Vitamin B_{12} Biotin Pantothenic acid Choline Vitamin C (ascorbic acid)	Vitamin A (retinol, beta-carotene) Vitamin D (1, 25 dihydroxy-cholecalciferol) Vitamin E (alpha-tocopherol) Vitamin K

Minerals

Humans require the 15 minerals listed in Table 1.12. Minerals are unlike other nutrients in that they consist of single atoms and carry a charge in solution. The charge (resulting from having an unequal number of electrons and protons)

metabolism The chemical changes that take place in the body. The conversion of glucose to energy or body fat is an example of a metabolic process.

antioxidants Chemical substances that prevent or repair damage to cells caused by exposure to oxidizing agents such as oxygen, ozone, and smoke and to other oxidizing agents normally produced in the body. Many different antioxidants are found in foods; some are made by the body.

phytochemicals (phyto = plants) Chemical substances in plants, some of which affect body processes in humans that may benefit health. Also called phytonutrients.

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Table 1.9 Summary of the vitamins

The Water-Soluble Vitamins		
	Primary Functions	**Consequences of Deficiency**
Thiamin (vitamin B_1) AI[a] Adult: 1.2 mg	• Coenzyme in the metabolism of carbohydrates, alcohol, and some amino acids • Required for the growth and maintenance of nerve and muscle tissues • Required for normal appetite	• Fatigue, weakness • Nerve disorders, mental confusion, apathy • Impaired growth • Swelling • Heart irregularity and failure
Riboflavin (vitamin B_2) AI Adult: 1.3 mg	• Coenzyme involved in energy metabolism of carbohydrates, proteins, and fats • Coenzyme function in cell division • Promotes growth and tissue repair • Promotes normal vision	• Reddened lips, cracks at both corners of the mouth • Fatigue
Niacin (vitamin B_3) RDA women: 14 mg men: 16 mg UL: 35 mg (from supplements and fortified foods)	• Coenzyme involved in energy metabolism • Coenzyme required for the synthesis of body fats • Helps maintain normal nervous system functions	• Skin disorders • Nervous and mental disorders • Diarrhea, indigestion • Fatigue
Vitamin B_6 (pyridoxine) AI Adult: 1.3 mg UL: 100 mg	• Coenzyme involved in amino acid, glucose, and fatty acid metabolism and neurotransmitter synthesis • Coenzyme in the conversion of tryptophan to niacin • Required for normal red blood cell formation • Required for the synthesis of lipids in the nervous and immune systems	• Irritability, depression • Convulsions, twitching • Muscular weakness • Dermatitis near the eyes • Anemia • Kidney stones
Folate (folacin, folic acid) RDA Adult: 400 mcg UL: 1,000 mcg (from supplements and fortified foods)	• Required for the conversion of homocysteine to methionine • Methyl (CH_3) group donor and coenzyme in DNA synthesis, gene expression and regulation • Required for the normal formation of red blood and other cells	• Megaloblastic cells and anemia • Diarrhea, weakness, irritability, paranoid behavior • Red, sore tongue • Increased blood homocysteine levels • Increased risk of neural tube defects and other malformations, low birthweight and preterm delivery (in pregnancy)
Vitamin B_{12} (cyanocobalamin) AI Adult: 2.4 mcg	• Coenzyme involved in the synthesis of DNA, RNA, and myelin • Required for the conversion of homocysteine to methionine • Needed for normal red blood cell development	• Neurological disorders (nervousness, tingling and numbness in fingers, brain degeneration) • Pernicious anemia characterized by large, oval-shaped red blood cells • Sore, beefy red, smooth tongue • Fatigue

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The Water-Soluble Vitamins (continued)			
	Consequences of Overdose	**Primary Food Sources**	**Highlights and Comments**
	• High intakes of thiamin are rapidly excreted by the kidneys. Oral doses of 500 mg/day or less considered safe.	• Grains and grain products (cereals, pasta, bread) • Pork	• Need increases with carbohydrate intake. • There is no "e" on the end of *thiamin*. • Deficiency rare in the United States; may occur in people with alcoholism. • Enriched grains and cereals prevent thiamin deficiency.
	• None known; high doses are rapidly excreted by the kidneys.	• Milk, yogurt, cheese • Grains and grain products (cereals, rice, pasta, bread) • Liver, fish, beef • Eggs	• Destroyed by exposure to light.
	• Flushing, headache, cramps, rapid heartbeat, nausea, diarrhea, decreased liver function with doses above 0.5 g/day	• Meats, fish • Grains and grain products (cereals, rice, pasta, bread)	• Niacin has a precursor—tryptophan. Tryptophan, an amino acid, is converted to niacin by the body. Much of our niacin intake comes from tryptophan. • High doses raise HDL cholesterol levels, decrease LDL cholesterol, and lower triglyceride levels.
	• Bone pain, loss of feeling in fingers and toes, muscular weakness, numbness, loss of balance (mimicking multiple sclerosis)	• Breakfast cereals • Brussels sprouts, sweet peppers, potatoes • Meats (all types)	• Vitamins go from B_3 to B_6 because B_4 and B_5 were found to be duplicates of vitamins already identified.
	• May mask signs of vitamin B_{12} deficiency (pernicious anemia), especially in older adults	• Ready-to-eat cereals, fortified grain products • Dark green, leafy vegetables • Dried beans	• Folate means "foliage." It was first discovered in leafy green vegetables. • This vitamin is easily destroyed by heat. • Synthetic form (folic acid) added to fortified grain products is better absorbed than naturally occurring folates. • Some individuals are genetically susceptible to folate deficiency. • Folate status has improved since folic acid fortification of refined grain products.
	• None known. Excess vitamin B_{12} is rapidly excreted by the kidneys or is not absorbed into the bloodstream. • Vitamin B_{12} injections may cause a temporary feeling of heightened energy.	• Fish, seafood, meats • Milk, cheese • Ready-to-eat cereals	• Older people, people who malabsorb B_{12}, and vegans are at risk for vitamin B_{12} deficiency. • Vitamin B_{12} is found in animal products and microorganisms only.

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Table 1.9 Summary of the vitamins (continued)

The Water-Soluble Vitamins (continued)		
	Primary Functions	**Consequences of Deficiency**
Biotin AI Adult 30 mcg	• Required by enzymes involved in fat, protein, and glycogen metabolism	• Seizures, vision problems • Hearing loss • Weakness
Pantothenic acid (pantothenate) AI Adult 5 mg	• Coenzyme involved in energy metabolism of carbohydrates and fats • Coenzyme in protein metabolism	• Fatigue, sleep disturbances, numbness, impaired coordination • Vomiting, nausea
Vitamin C (ascorbic acid) RDA Adult 90 mg UL: 2,000 mg	• Required for collagen synthesis • Acts as an antioxidant; protects LDL cholesterol, eye tissues, sperm proteins, DNA, and lipids against oxidation • Required for the conversion of Fe^{11} to $Fe1^{11}$ • Required for neurotransmitters and steroid hormone synthesis	• Bleeding and bruising easily due to weakened blood vessels, cartilage, and other tissues containing collagen • Slow recovery from infections and poor wound healing • Fatigue, depression
Choline (a vitamin-like nutrient) AI Adult 550 mg UL: 3.5 g	• Serves as a structural and signaling component of cell membranes • Required for the normal development of memory and attention processes during early life • Required for the transport and metabolism of fat and cholesterol	• Fatty liver • Infertility • Hypertension
The Fat-Soluble Vitamins		
Vitamin A RDA Adult 900 mcg UL: 3,000 mcg	• Needed for the formation and maintenance of mucous membranes, skin, bone • Needed for vision in dim light	• Increased incidence and severity of infection (including measles) • Impaired vision, xerophthalmia, blindness • Inability to see in dim light
Vitamin E (alpha-tocopherol) RDA Adult 15 mg UL: 1,000 mg	• Acts as an antioxidant, prevents damage to cell membranes in blood cells, lungs, and other tissues by repairing damage caused by free radicals • Participates in the regulation of gene expression	• Muscle loss, nerve damage • Anemia • Weakness

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The Water-Soluble Vitamins (continued)			
	Consequences of Overdose	**Primary Food Sources**	**Highlights and Comments**
	• None known. Excesses are rapidly excreted.	• Grain and cereal products • Meats, dried beans, cooked eggs • Vegetables	• Deficiency is extremely rare. May be induced by the overconsumption of raw eggs.
	• None known. Excesses are rapidly excreted.	• Many foods, including meats, grains, vegetables, fruits, and milk	• Deficiency is very rare.
	• Regular intake of 1 g or more per day of supplemental vitamin C can cause nausea, cramps, diarrhea; and increase the risk of kidney stones.	• Fruits: oranges, lemons, limes, strawberries, cantaloupe, honeydew melon, grapefruit, kiwi fruit, mango, papaya • Vegetables: broccoli, green and red peppers, collards, cabbage, tomatoes, asparagus, potatoes • Ready-to-eat cereals	• Need increases among smokers (to 110–125 mg/day). • Is fragile; easily destroyed by heat and exposure to air. • Supplements may decrease severity of symptoms of colds. • Deficiency may develop within 3 weeks of very low intake.
	• Low blood pressure • Sweating, diarrhea • Fishy body odor • Liver damage	• Beef • Eggs • Pork • Dried beans • Fish • Milk	• Most of the choline we consume from foods comes from its location in cell membranes. • Lecithin, an additive commonly found in processed foods, is a rich source of choline. • Choline is primarily found in animal products. • It is considered a B-complex vitamin.
	The Fat-Soluble Vitamins (continued)		
	• Vitamin A toxicity (hypervitamosis A) with acute doses of 500,000 IU, or long-term intake of 50,000 IU per day. • Nausea, irritability, blurred vision, weakness • Increased pressure in the skull, headache • Liver damage • Hair loss, dry skin • Birth defects	• Vitamin A is found in animal products only • Liver, clams • Low-fat milk, American cheese • Ready-to-eat cereals	• Beta-carotene is a vitamin A precursor or "provitamin"; it functions as an antioxidant. • Symptoms of vitamin A toxicity may mimic those of brain tumors and liver disease. • 1 mcg vitamin A = 3.33 IU vitamin A.
	• Intakes of up to 800 IU per day are unrelated to toxic side effects; over 800 IU per day may increase bleeding (blood-clotting time). • Avoid supplement use if aspirin, anticoagulants, or fish oil supplements are taken regularly.	• Vegetable oil • Salad dressings, mayonnaise • Whole grains, wheat germ • Leafy, green vegetables, asparagus • Nuts and seeds	• Vitamin E is destroyed by exposure to oxygen and heat. • Oils naturally contain vitamin E; it's there to protect the fat from breakdown due to free radicals. • Eight forms of vitamin E exist, and each has different antioxidant strengths. • 1 mg vitamin E = 1.49 IU.

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Table 1.9 Summary of the vitamins (continued)

The Fat-Soluble Vitamins (continued)		
	Primary Functions	**Consequences of Deficiency**
Vitamin D (Vitamin D_2 = ergocalciferol, Vitamin D_3 = cholicalciferol) RDA Adult 20 mcg (600 IU) UL: 100 mcg (4,000 IU)	• Required for calcium and phosphorus absorption and for metabolism in the intestines and bone, and for their utilization in bone and teeth formation, nerve and muscle activity • Inhibits inflammation • Participates in insulin secretion and blood glucose level maintenance	• Weak, deformed bones (children) • Loss of calcium from bones (adults), osteoporosis • Increased risk of inflammation-related diseases and death from all causes
Vitamin K (phylloquinone, menaquinone) AI Adult 120 mcg	• Regulation of synthesis of blood-clotting proteins • Aids in the incorporation of calcium into bones	• Bleeding, bruises • Decreased calcium in bones • Deficiency is rare; may be induced by the long-term use (months or more) of antibiotics

[a]AIs (Adequate Intakes) and RDAs (Recommended Dietary Allowances) are for 19–30-year-olds; ULs (Upper Limits) are for 19–70-year-olds.

Table 1.10 Food sources of vitamins

Thiamin					
Food	**Serving Size**	**Thiamin (mg)**	**Food**	**Serving Size**	**Thiamin (mg)**
Meats:			Macaroni	½ cup	0.2
Ham	3 oz	0.6	Rice	½ cup	0.2
Pork	3 oz	0.5	Bread	1 slice	0.1
Beef	3 oz	0.4	**Vegetables:**		
Liver	3 oz	0.2	Peas	½ cup	0.2
Nuts and seeds:			Lima beans	½ cup	0.2
Pistachios	¼ cup	0.3	Corn	½ cup	0.2
Macadamia nuts	¼ cup	0.2	**Fruits:**		
Peanuts, dry roasted	¼ cup	0.2	Orange juice	1 cup	0.2
Grains:			Orange	1	0.1
Breakfast cereals	1 cup	0.3–1.4	Avocado	½	0.1
Flour tortilla	1	0.2			

Riboflavin					
Food	**Serving Size**	**Riboflavin (mg)**	**Food**	**Serving Size**	**Riboflavin (mg)**
Milk and milk products:			**Vegetables:**		
Milk	1 cup	0.5	Collard greens	½ cup	0.3
2% milk	1 cup	0.5	Spinach, cooked	½ cup	0.2
Yogurt, low-fat	1 cup	0.5	Broccoli	½ cup	0.1
Skim milk	1 cup	0.4	Yogurt	1 cup	0.4
Tuna	3 oz	0.1	American cheese	1 oz	0.1
			Cheddar cheese	1 oz	0.1

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The Fat-Soluble Vitamins (continued)			
	Consequences of Overdose	**Primary Food Sources**	**Highlights and Comments**
	• Intellectual disability in young children, severe illness and dementia in adults • Abnormal bone growth and formation • Nausea, diarrhea, irritability, weight loss • Deposition of calcium in organs such as the kidneys, liver, and heart	• Vitamin D–fortified milk, breakfast cereals, and other foods • Fish and shellfish	• Vitamin D_3 is the most active form of this vitamin. • Vitamin D is synthesized from a form of cholesterol in skin cells upon exposure of the skin to UV rays from the sun. • Inadequate vitamin D status is common, individuals with dark skin are at higher risk. • Breastfed infants with little sun exposure can benefit from vitamin D supplements. • 1 mcg vitamin D = 40 IU.
	• Toxicity is a problem only when synthetic forms of vitamin K are taken in excessive amounts; that may cause liver disease.	• Leafy, green vegetables • Grain products	• Vitamin K is produced to some extent by gut bacteria. • Newborns are given a vitamin K because they have "sterile" guts and consequently no vitamin K–producing bacteria.

Table 1.10 Food sources of vitamins (continued)

Riboflavin (continued)					
Food	**Serving Size**	**Riboflavin (mg)**	**Food**	**Serving Size**	**Riboflavin (mg)**
Meats:			**Grains:**		
Liver	3 oz	3.6	Breakfast cereals	1 cup	0.1–1.7
Pork chop	3 oz	0.3	Macaroni	½ cup	0.1
Beef	3 oz	0.2	Bread	1 slice	0.1
Eggs:					
Egg	1	0.2			
Niacin					
Food	**Serving Size**	**Niacin (mg)**	**Food**	**Serving Size**	**Niacin (mg)**
Meats:			Almonds	¼ cup	1.3
Liver	3 oz	14.0	**Vegetables:**		
Tuna	3 oz	7.0	Asparagus	½ cup	1.2
Turkey	3 oz	4.0	Corn	½ cup	1.2
Chicken	3 oz	11.0	Green beans	½ cup	1.2
Salmon	3 oz	6.9	**Grains:**		
Veal	3 oz	6.4	Breakfast cereals	1 cup	5.0–20.0
Beef (round steak)	3 oz	4.0	Brown rice	½ cup	1.5
Pork	3 oz	4.0	Noodles, enriched	½ cup	1.0
Haddock	3 oz	3.9	Rice, white, enriched	½ cup	1.2
Shrimp	3 oz	2.2	Bread, enriched	1 slice	1.1
Nuts and seeds:					
Peanuts, dry roasted	¼ cup	4.9			

(continued)

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Table 1.10 Food sources of vitamins (continued)

Food	Serving Size	Vitamin B_6 (mg)	Food	Serving Size	Vitamin B_6 (mg)
Vitamin B_6					
Meats:			**Fruits:**		
Liver	3 oz	0.8	Banana	1	0.4
Fish	3 oz	0.3–0.6	Avocado	½ cup	0.3
Chicken	3 oz	0.4	Watermelon	1 cup	0.3
Ham	3 oz	0.4	**Vegetables:**		
Hamburger	3 oz	0.4	Brussels sprouts	½ cup	0.2
Veal	3 oz	0.4	Potato	½ cup	0.4
Pork	3 oz	0.3	Sweet potato	½ cup	0.3
Beef	3 oz	0.2	Carrots	½ cup	0.2
Grains:			Sweet peppers	½ cup	0.2
Breakfast cereals	1 cup	0.5–7.0			
Folate					
Food	**Serving Size**	**Folate (mcg)**	**Food**	**Serving Size**	**Folate (mcg)**
Vegetables:			Romaine lettuce	1 cup	65
Garbanzo beans	½ cup	141	Peas	½ cup	47
Spinach, cooked	½ cup	131	**Grains:**[a]		
Navy beans	½ cup	128	Ready-to-eat cereals	1 cup/1 oz	100–400
Asparagus	½ cup	120	Rice	½ cup	77
Lima beans	½ cup	76	Noodles	½ cup	45
Collard greens, cooked	½ cup	65	Wheat germ	2 Tbsp	40
Vitamin B_{12}					
Food	**Serving Size**	**Vitamin B_{12} (mcg)**	**Food**	**Serving Size**	**Vitamin B_{12} (mcg)**
Fish and seafood:			**Milk and milk products:**		
Oysters	3 oz	13.8	Skim milk	1 cup	1.0
Scallops	3 oz	3.0	Milk	1 cup	0.9
Salmon	3 oz	2.3	Yogurt	1 cup	0.8
Clams	3 oz	2.0	Cottage cheese	½ cup	0.7
Crab	3 oz	1.8	American cheese	1 oz	0.2
Tuna	3 oz	1.8	Cheddar cheese	1 oz	0.2
Meats:			**Grains:**		
Liver	3 oz	6.8	Breakfast cereals	1 cup	0.6–12.0
Beef	3 oz	2.2	**Eggs:**		
Veal	3 oz	1.7	Egg	1	0.6
Vitamin C					
Food	**Serving Size**	**Vitamin C (mg)**	**Food**	**Serving Size**	**Vitamin C (mg)**
Fruits:			Cranberry juice cocktail	1 cup	90
Guava	½ cup	180	Orange	1	85
Orange juice, vitamin C-fortified	1 cup	108	Strawberries, fresh	1 cup	84
			Cantaloupe	¼ whole	63
Kiwi fruit	1	108	Grapefruit	1 medium	51
Grapefruit juice, fresh	1 cup	94			

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Table 1.10 Food sources of vitamins (continued)

Vitamin C (continued)					
Food	**Serving Size**	**Vitamin C (mg)**	**Food**	**Serving Size**	**Vitamin C (mg)**
Raspberries, fresh	1 cup	31	Green peppers	½ cup	60
Watermelon	1 cup	15	Collard greens	½ cup	48
Vegetables:			Vegetable (V-8) juice	¾ cup	45
Sweet red peppers	½ cup	142	Tomato juice	¾ cup	33
Cauliflower, raw	½ cup	75	Cauliflower, cooked	½ cup	30
Broccoli	½ cup	70	Potato	1 medium	29
Brussels sprouts	½ cup	65	Tomato	1 medium	23

Choline					
Food	**Serving Size**	**Choline (mg)**	**Food**	**Serving Size**	**Choline (mg)**
Meats:			Collards, cooked	½ cup	39
Beef	3 oz	111	Black-eyed-peas (Cowpeas)	½ cup	39
Pork chop	3 oz	94	Chickpeas (garbanzo beans)	½ cup	35
Lamb	3 oz	89	Brussels sprouts	½ cup	32
Ham	3 oz	87	Broccoli	½ cup	32
Beef	3 oz	85	Collard greens	½ cup	30
Turkey	3 oz	70	Refried beans	½ cup	29
Salmon	3 oz	56	**Milk and milk products:**		
Eggs:			Milk, 2%	1 cup	40
Egg	1 large	126	Cottage cheese, low-fat	½ cup	37
Vegetables:			Yogurt, low-fat	1 cup	35
Baked beans	½ cup	50			
Navy beans, boiled	½ cup	41			

Vitamin A					
Food	**Serving Size**	**Vitamin A Retinol (mcg)**	**Food**	**Serving Size**	**Vitamin A Retinol (mcg)**
Meats:			**Milk and milk products:**		
Liver	3 oz	9,124	American cheese	1 oz	114
Clams	3 oz	145	Fat-free/low-fat milk	1 cup	100
Fortified breakfast cereals	1 cup	150	Whole milk	1 cup	58
			Egg	1	84

Beta-Carotene					
Food	**Serving Size**	**Beta-Carotene (mcg) Retinol Equivalents, RE**	**Food**	**Serving Size**	**Beta-Carotene (mcg) Retinol Equivalents, RE**
Vegetables:			Beet greens, cooked	½ cup	276
Sweet potatoes	½ cup	961	Swiss chard, cooked	½ cup	268
Pumpkin, canned	½ cup	953	Winter squash, cooked	½ cup	268
Carrots, raw	½ cup	665	Vegetable juice	1 cup	200
Spinach, cooked	½ cup	524	Romaine lettuce	1 cup	162
Collard greens, cooked	½ cup	489	**Fruit:**		
Kale, cooked	½ cup	478	Cantaloupe	½ cup	135
Turnip greens, cooked	½ cup	441	Apricots, fresh	4	134

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Table 1.10 Food sources of vitamins (continued)

Vitamin E

Food	Serving Size	Vitamin E (mg)	Food	Serving Size	Vitamin E (mg)
Nuts and seeds:			**Fish and seafood:**		
Sunflower seeds	1 oz	7.4	Crab	3 oz	4.5
Almonds	1 oz	7.3	Shrimp	3 oz	3.7
Hazelnuts (filberts)	1 oz	4.3	Fish	3 oz	2.4
Mixed nuts	1 oz	3.1	**Grains:**		
Pine nuts	1 oz	2.6	Wheat germ	2 Tbsp	4.2
Peanut butter	2 Tbsp	2.5	Whole wheat bread	1 slice	2.5
Peanuts	1 oz	2.2	**Vegetables:**		
Vegetable oil:			Spinach, cooked	½ cup	3.4
Sunflower oil	1 Tbsp	5.6	Yellow bell pepper	1	2.8
Safflower oil	1 Tbsp	5.6	Turnip greens, cooked	½ cup	2.2
Canola oil	1 Tbsp	2.4	Swiss chard, cooked	½ cup	1.7
Peanut oil	1 Tbsp	2.1	Asparagus	½ cup	1.5
Corn oil	1 Tbsp	1.9	Sweet potato	½ cup	1.5
Olive oil	1 Tbsp	1.9			
Salad dressing	2 Tbsp	1.5			

Vitamin D

Food	Serving Size	Vitamin D (mcg)	Vitamin D IU	Food	Serving Size	Vitamin D (mcg)	Vitamin D IU
Fish and seafoods:				**Other vitamin D–fortified foods:**			
Swordfish	3 oz	14	566	Orange juice	1 cup	2.5	100
Trout	3 oz	13	502	Rice milk	1 cup	2.5	100
Salmon	3 oz	11	447	Soy milk	1 cup	2.5	100
Tuna, light, canned in oil	3 oz	5.7	228	Yogurt	1 cup	2.0	80
Halibut	3 oz	4.9	196	Margarine	2 tsp	1.2	48
Tuna, light, canned in water	3 oz	3.8	152	**Milk:**			
Tuna, white, canned in water	3 oz	1.7	68	Milk, whole	1 cup	3.2	128
Vitamin D–fortified breakfast cereals:				Milk, 2%	1 cup	2.9	116
Whole grain Total	1 cup	3.3	132	Milk, 1%	1 cup	2.9	116
Total Raisin Bran	1 cup	2.6	104	Milk, skim (nonfat)	1 cup	2.9	116
Corn Pops, Kellogg's	1 cup	1.2	48				
Crispix, Kellogg's	1 cup	1.2	48				

Vitamin K

Food	Serving Size	Vitamin K (mcg)	Food	Serving Size	Vitamin K (mcg)
Vegetables and fruits			Spinach, raw	½ cup	73
Kale, cooked	½ cup	531	Lettuce, leafy green	1 cup	71
Spinach, cooked	½ cup	444	Asparagus, cooked	4 spears	48
Turnip greens, cooked	½ cup	426	Kiwifruit	½ cup	37
Broccoli, cooked	½ cup	110	Berries, blue or black	1 cup	29
Brussels sprouts, cooked	½ cup	109	Okra, cooked	½ cup	23
Mustard greens, cooked	½ cup	105	Peas, cooked	½ cup	21
Cabbage, cooked	½ cup	82	Leeks	1	16

[a]Fortified, refined grain products such as bread, rice, pasta, and crackers provide approximately 60 micrograms of folic acid per standard serving.

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Table 1.11 Good sources of antioxidant-rich foods[23,24]



Judith Brown

Artichokes	Pomegranate
Cranberries	Blackberries
Blueberries, domestic	Tomatoes
Coffee, brewed	Blueberries, wild
Red cabbage	Strawberries
Pecans	Raspberries
Cloves, ground	Chocolate, dark
Grape juice	Cranberry juice
	Wine, red
	Pineapple juice
	Guava nectar
	Mango nectar

carried by minerals allows them to combine with other minerals to form stable complexes in bone, teeth, cartilage, and other tissues. In body fluids, charged minerals serve as a source of electrical power that stimulates muscles to contract (e.g., the heart to beat) and nerves to react. Minerals also help the body maintain an adequate amount of water in tissues and control how acidic or basic body fluids remain.

The tendency of minerals to form complexes has implications for the absorption of minerals from food. Calcium and zinc, for example, may combine with other minerals in supplements or with dietary fiber and form complexes that cannot be absorbed. Therefore, in general, the proportion of total mineral intake that is absorbed is less than for vitamins.

Functions, consequences of deficiency and overdose, primary food sources, and comments about the 15 minerals needed by humans are summarized in Table 1.13.

Recommended Intake of Minerals Recommendations for intake of minerals are presented in the tables on the inside front covers of this text. Note that Tolerable Upper Levels of Intake for many minerals are also given in a separate table. Table 1.14 lists food sources of each essential mineral.

Water

Water is the last, but not the least, nutrient category. Adults are about 60 to 70 percent water by weight. Water provides the medium in which most chemical reactions take place in the body. It plays a role in energy transformation, the excretion of wastes, and temperature regulation.

People need enough water to replace daily losses from perspiration, urination, and exhalation. In normal weather conditions (less than 85°F) with normal physical activity levels, the total water requirement from foods and fluids for adult men is 15 to 16 cups/day and for women 11 cups/day. Total water intake includes drinking water, water in beverages, and water that is a part of food. People generally consume about 75 percent of their water intake from water and other fluids and 25 percent from foods. The need for water is generally met by consuming sufficient fluids to satisfy thirst, and the need for water is greater in hot and humid climates or when physical activity levels are high. Adequate consumption of water is indicated by the excretion of urine that is pale yellow and normal in volume.[25,26,27]

Table 1.12 Minerals required by humans

Calcium	Fluoride	Chromium
Phosphorus	Iodine	Molybdenum
Magnesium	Selenium	Sodium
Iron	Copper	Potassium
Zinc	Manganese	Chloride

Dietary Sources of Water The best sources of water are tap and bottled water; nonalcoholic beverages such as fruit juice, milk, and vegetable juice, and brothy soups. Alcohol tends to increase water loss though urine, so beverages such as beer and wine are not as "hydrating" as water is. Caffeinated beverages are hydrating in people who are accustomed to consuming them.[26,27]

Nutrition Principle 3

Health problems related to nutrition originate within cells.

Nutrient Functions at the Cellular Level

The functions of each cell are maintained by the nutrients it receives. Problems arise when a cell's need for nutrients differs from the amounts that are available. Cells (Figure 1.5) are the building blocks of tissues (such as bones and muscles), organs (e.g., the heart, kidney, and liver), and systems (such as the circulatory and respiratory systems). Optimal cell health and functions are maintained when a nutritional and environmental utopia exists within and around cells. This state of cellular nutrient conditions supports **homeostasis** in the body.

Disruptions in the availability of nutrients, or the presence of harmful substances in the cell's environment, initiate diseases and disorders that eventually affect tissues, organs, and systems. For example, folate, a B vitamin, is required for protein synthesis within cells. When too little folate is available, cells produce proteins with abnormal shapes and functions. Abnormalities in the shape of red blood cell proteins lead to functional changes that produce loss of appetite, weakness, and irritability.

Nutrition Principle 4

Poor nutrition can result from both inadequate and excessive levels of nutrient intake.

homeostasis Constancy of the internal environment. The balance of fluids, nutrients, gases, temperature, and other conditions needed to ensure ongoing, proper functioning of cells and, therefore, all parts of the body.

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Table 1.13 Summary of minerals

	Primary Functions	Consequences of Deficiency
Calcium AI* adult: 1,000 mg UL: 2,500 mg	• Component of bones and teeth • Required for muscle and nerve activity, blood clotting	• Poorly mineralized, weak bones (osteoporosis) • Rickets in children • Osteomalacia (rickets in adults) • Stunted growth in children • Convulsions, muscle spasms
Phosphorus RDA adult: 700 mg UL: 4,000 mg	• Component of bones and teeth • Component of certain enzymes and other substances involved in energy formation • Required for maintenance of acid-base balance of body fluids	• Loss of appetite • Nausea, vomiting • Weakness • Confusion • Loss of calcium from bones
Magnesium RDA women: 310 mg/day men: 400 mg/day UL: 350 mg (from supplements only)	• Component of bones and teeth • Needed for nerve activity • Activates hundreds of enzymes involved in metabolism	• Stunted growth in children • Weakness • Muscle spasms • Personality changes
Iron RDA women: 18 mg men: 8 mg UL: 45 mg	• Transports oxygen as a component of hemoglobin in red blood cells • Component of myoglobin (a muscle protein) • Required for certain reactions involving energy formation	• Iron deficiency • Iron-deficiency anemia • Weakness, fatigue • Hair loss • Pale appearance • Reduced attention span and resistance to infection • Intellectual disability, developmental delay in children • Ice craving • Decreased resistance to infection
Zinc RDA women: 8 mg men: 11 mg UL: 40 mg	• Required for the activation of many enzymes involved in the reproduction of proteins • Component of insulin, many enzymes	• Growth failure • Delayed sexual maturation • Slow wound healing • Loss of taste and appetite • In pregnancy, low-birth-weight infants and preterm delivery
Fluoride RDA women: 3 mg men: 4 mg UL: 10 mg	• Component of bones and teeth (enamel)	• Tooth decay and other dental diseases
Iodine RDA adult: 150 mg UL: 1,100 mg	• Required for the synthesis of thyroid hormones that help regulate energy production and growth • Required for normal brain development	• Goiter • Cretinism (intellectual disability, hearing loss, growth failure)

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	Consequences of Overdose	Primary Food Sources	Highlights and Comments
	• Drowsiness • Calcium deposits in kidneys, liver, and other tissues • Suppression of bone remodeling • Decreased zinc absorption	• Milk and milk products (cheese, yogurt) • Calcium-fortified foods	• The average intake of calcium among U.S. women is approximately 60% of the DRI. • One in four women and one in eight men in the United States develop osteoporosis. • Adequate calcium and vitamin D status must be maintained to prevent bone loss.
	• Muscle spasms	• Milk and milk products (cheese, yogurt) • Meats • Seeds, nuts	• Deficiency is generally related to disease processes.
	• Diarrhea • Dehydration • Impaired nerve activity due to disrupted utilization of calcium	• Plant foods (dried nuts, peanuts, potatoes, green vegetables) • Ready-to-eat cereals	• Magnesium is primarily found in plant foods. • Average intake among U.S. adults is below the RDA.
	• Hemochromatosis (“iron poisoning”) • Vomiting, abdominal pain, diarrhea • Blue coloration of skin • Iron deposition in liver and heart • Decreased zinc absorption • Oxidation-related damage to tissues and organs	• Liver, beef, pork • Dried beans • Iron-fortified cereals • Prunes, apricots, raisins • Spinach • Bread	• Cooking foods in iron and stainless-steel pans increases the iron content of the foods. • Vitamin C, meat, and alcohol increase iron absorption. • Iron deficiency is the most common nutritional deficiency in the world. • Average iron intake of young children and women in the United States is low.
	• Over 25 mg/day is associated with nausea, vomiting, weakness, fatigue, susceptibility to infection, copper deficiency, and metallic taste in mouth. • Increased blood lipids	• Meats (all kinds) • Grains • Nuts • Dried beans • Ready-to-eat cereals	• Like iron, zinc is better absorbed from meats than from plants • Marginal zinc deficiency may be common, especially in children. • Zinc supplements may decrease duration and severity of the common cold.
	• Fluorosis • Brittle bones • Mottled teeth • Nerve abnormalities	• Fluoridated water and foods and beverages made with it • White grape juice	• Toothpastes, mouth rinses, and other dental care products may provide fluoride. • Fluoride overdose has been caused by ingestion of fluoridated toothpaste.
	• Over 1 mg/day may produce pimples, goiter, and decreased thyroid function.	• Iodized salt • Milk and milk products • Seaweed, seafoods • Bread from commercial bakeries	• Iodine deficiency remains a major health problem in some developing countries. • Amount of iodine in plants depends on iodine content of soil. • The need for iodine increases 50% during pregnancy.

(continued)

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Table 1.13 Summary of minerals (continued)

	Primary Functions	Consequences of Deficiency
Selenium RDA adult: 55 mcg UL: 400 mcg	• Acts as an antioxidant in conjunction with vitamin E (protects cells from damage due to exposure to oxygen) • Needed for thyroid hormone production	• Anemia • Muscle pain and tenderness • Keshan disease (heart failure), Kashin-Beck disease (joint disease)
Copper RDA adult: 900 mcg UL: 10,000 mcg	• Component of enzymes involved in the body's utilization of iron and oxygen • Functions in growth, immunity, cholesterol and glucose utilization, brain development	• Anemia • Seizures • Nerve and bone abnormalities in children • Stunted growth
Manganese AI women: 1.8 mg men: 2.3 mg	• Required for the formation of body fat and bone	• Weight loss • Rash • Nausea and vomiting
Chromium AI adult: 0.25 mg	• Required for the normal utilization of glucose and fat	• Elevated blood glucose and triglyceride levels • Weight loss
Molybdenum RDA adult: 45 mcg UL: 2,000 mcg	• Component of enzymes involved in the transfer of oxygen from one molecule to another	• Rapid heartbeat and breathing • Nausea, vomiting • Coma
Sodium AI adult: 1.5 grams	• Regulation of acid-base balance in body fluids • Maintenance of water balance in body tissues • Activation of muscles and nerves	• Weakness • Apathy • Poor appetite • Muscle cramps • Headache • Swelling
Potassium AI adult: 4,700 mg	• Same as for sodium	• Weakness • Irritability, mental confusion • Irregular heartbeat • Paralysis
Chloride AI adult: 2,300 mg UL: 3,600 mg	• Component of hydrochloric acid secreted by the stomach (used in digestion) • Maintenance of acid-base balance of body fluids • Maintenance of water balance in the body	• Muscle cramps • Apathy • Poor appetite • Long-term intellectual disability in infants

*AIs and RDAs are for women and men 19–30 years of age; ULs are males and females 19–70 years of age.

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	Consequences of Overdose	Primary Food Sources	Highlights and Comments
	• "Selenosis"; symptoms of selenosis are hair and fingernail loss, weakness, liver damage, irritability, and "garlic" or "metallic" breath.	• Meats and seafoods • Eggs	• Content of foods depends on amount of selenium in soil, water, and animal feeds. • Selenium supplements have not been found to prevent cancer.
	• Wilson's disease (excessive accumulation of copper in the liver and kidneys). • Vomiting, diarrhea • Tremors • Liver disease	• Potatoes • Grains • Dried beans • Nuts and seeds • Seafood	• Toxicity can result from copper pipes and cooking pans. • Average intake in the United States is below the RDA.
	• Infertility in men • Disruptions in the nervous system, learning impairment • Muscle spasms	• Whole grains • Coffee, tea • Dried beans • Nuts	• Toxicity is related to overexposure to manganese dust in miners or contaminated ground water.
	• Kidney and skin damage	• Whole grains • Wheat germ • Liver, meat • Beer, wine • Oysters	• Toxicity usually results from exposure in chrome-making industries or overuse of supplements. • Supplements do not build muscle mass, increase endurance, or reduce blood glucose levels.
	• Loss of copper from the body • Joint pain • Growth failure • Anemia • Gout	• Dried beans • Grains • Dark-green vegetables • Liver • Milk and milk products	• Deficiency is extraordinarily rare.
	• High blood pressure in susceptible people • Kidney disease • Heart problems	• Foods processed with salt • Cured foods (corned beef, ham, bacon, pickles, sauerkraut) • Table and sea salt • Milk, cheese • Salad dressing	• Very few foods naturally contain much sodium; processed foods are the leading source. • High-sodium diets are associated with hypertension, particularly in "salt-sensitive" people. • Kidney disease and excessive water consumption are related to sodium depletion.
	• Irregular heartbeat, heart attack	• Plant foods (potatoes, squash, lima beans, tomatoes, plantains, bananas, oranges, orange juice, avocados) • Meats • Milk and milk products • Coffee	• Content of vegetables is often reduced in processed foods. • Diuretics (water pills), vomiting, diarrhea may deplete potassium. • Salt substitutes often contain potassium. • Potassium intake tracks with vegetables and fruit intake.
	• Vomiting	• Same as for sodium (most of the chloride in our diets comes from salt)	• Excessive vomiting and diarrhea may cause chloride deficiency. • Legislation regulating the composition of infant formulas was enacted in response to formula-related chloride deficiency and subsequent intellectual disability in infants.

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Table 1.14 Food sources of minerals

Magnesium

Food	Amount	Magnesium (mg)	Food	Amount	Magnesium (mg)
Legumes:			**Vegetables:**		
Lentils, cooked	½ cup	134	Bean sprouts	½ cup	98
Split peas, cooked	½ cup	134	Black-eyed peas	½ cup	58
Tofu	½ cup	130	Spinach, cooked	½ cup	48
Nuts:			Lima beans	½ cup	32
Peanuts	¼ cup	247	**Milk and milk products:**		
Cashews	¼ cup	93	Milk	1 cup	30
Almonds	¼ cup	80	Cheddar cheese	1 oz	8
Grains:			American cheese	1 oz	6
Bran buds	1 cup	240	**Meats:**		
Wild rice, cooked	½ cup	119	Chicken	3 oz	25
Breakfast cereal, fortified	1 cup	85	Beef	3 oz	20
Wheat germ	2 Tbsp	45	Pork	3 oz	20

Calcium[a]

Food	Amount	Calcium (mg)	Food	Amount	Calcium (mg)
Milk and milk products:			Ice milk	1 cup	180
Yogurt, low-fat	1 cup	413	American cheese	1 oz	175
Milk shake (low-fat frozen yogurt)	1¼ cup	352	Custard	½ cup	150
			Cottage cheese	½ cup	70
Yogurt with fruit, low-fat	1 cup	315	Cottage cheese, low-fat	½ cup	69
Skim milk	1 cup	301	**Vegetables:**		
1% milk	1 cup	300	Spinach, cooked	½ cup	122
2% milk	1 cup	298	Kale	½ cup	47
3.25% milk (whole)	1 cup	288	Broccoli	½ cup	36
Swiss cheese	1 oz	270	**Legumes:**		
Milk shake (whole milk)	1¼ cup	250	Tofu	½ cup	260
Frozen yogurt, low-fat	1 cup	248	Dried beans, cooked	½ cup	60
Frappuccino	1 cup	220	**Foods fortified with calcium:**		
Cheddar cheese	1 oz	204	Orange juice	1 cup	350
Frozen yogurt	1 cup	200	Frozen waffles	2	300
Cream soup	1 cup	186	Soy milk	1 cup	200–400
Pudding	½ cup	185	Breakfast cereals	1 cup	150–1000
Ice cream	1 cup	180			

Selenium

Food	Amount	Selenium (mcg)	Food	Amount	Selenium (mcg)
Seafood:			Egg	1 medium	37
Lobster	3 oz	66	Ham	3 oz	29
Tuna	3 oz	60	Beef	3 oz	22
Shrimp	3 oz	54	Bacon	3 oz	21
Oysters	3 oz	48	Chicken	3 oz	18
Fish	3 oz	40	Lamb	3 oz	14
Meats/Eggs:			Veal	3 oz	10
Liver	3 oz	56			

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Table 1.14 Food sources of minerals (continued)

Zinc

Food	Amount	Zinc (mg)
Meats:		
Liver	3 oz	4.6
Beef	3 oz	4.0
Crab	½ cup	3.5
Lamb	3 oz	3.5
Turkey ham	3 oz	2.5
Pork	3 oz	2.4
Chicken	3 oz	2.0
Legumes:		
Dried beans, cooked	½ cup	1.0
Split peas, cooked	½ cup	0.9
Grains:		
Breakfast cereal, fortified	1 cup	1.5–4.0
Wheat germ	2 Tbsp	2.4
Oatmeal, cooked	1 cup	1.2
Bran flakes	1 cup	1.0
Brown rice, cooked	½ cup	0.6
White rice	½ cup	0.4
Nuts and seeds:		
Pecans	¼ cup	2.0
Cashews	¼ cup	1.8
Sunflower seeds	¼ cup	1.7
Peanut butter	2 Tbsp	0.9
Milk and milk products:		
Cheddar cheese	1 oz	1.1
Whole milk	1 cup	0.9
American cheese	1 oz	0.8

Sodium

Food	Amount	Sodium (mg)
Miscellaneous:		
Salt	1 tsp	2,132
Dill pickle	1 (4½ oz)	1,930
Sea salt	1 tsp	1,716
Ravioli, canned	1 cup	1,065
Spaghetti with sauce, canned	1 cup	955
Baking soda	1 tsp	821
Beef broth	1 cup	810
Chicken broth	1 cup	770
Gravy	¼ cup	720
Italian dressing	2 Tbsp	720
Pretzels	5 (1 oz)	500
Green olives	5	465
Pizza with cheese	1 wedge	455
Soy sauce	1 tsp	444
Cheese twists	1 cup	329
Bacon	3 slices	303
French dressing	2 Tbsp	220
Potato chips	1 oz (10 pieces)	200
Catsup	1 Tbsp	155
Meats:		
Corned beef	3 oz	808
Ham	3 oz	800
Fish, canned	3 oz	735
Meat loaf	3 oz	555
Sausage	3 oz	483
Hot dog	1	477
Fish, smoked	3 oz	444
Bologna	1 oz	370
Milk and milk products:		
Cream soup	1 cup	1070
Cottage cheese	½ cup	455
American cheese	1 oz	405
Cheese spread	1 oz	274
Parmesan cheese	1 oz	247
Gouda cheese	1 oz	232
Cheddar cheese	1 oz	175
Skim milk	1 cup	125
Whole milk	1 cup	120
Grains:		
Bran flakes	1 cup	363
Cornflakes	1 cup	325
Croissant	1 medium	270
Bagel	1	260
English muffin	1	203
White bread	1 slice	130
Whole wheat bread	1 slice	130
Saltine crackers	4 squares	125

(continued)

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Table 1.14 Food sources of minerals (continued)

Iron

Food	Amount	Iron (mg)	Food	Amount	Iron (mg)
Meat and meat alternatives:			Rye bread	1 slice	1.0
Liver	3 oz	7.5	Whole wheat bread	1 slice	0.8
Round steak	3 oz	3.0	White bread	1 slice	0.6
Hamburger, lean	3 oz	3.0	**Fruits:**		
Baked beans	½ cup	3.0	Prune juice	1 cup	9.0
Pork	3 oz	2.7	Apricots, dried	½ cup	2.5
White beans	½ cup	2.7	Prunes	5 medium	2.0
Soybeans	½ cup	2.5	Raisins	¼ cup	1.3
Pork and beans	½ cup	2.3	Plums	3 medium	1.1
Fish	3 oz	1.0	**Vegetables:**		
Chicken	3 oz	1.0	Spinach, cooked	½ cup	2.3
Grains:			Lima beans	½ cup	2.2
Breakfast cereal, iron-fortified	1 cup	8.0 (4–18)	Black-eyed peas	½ cup	1.7
			Peas	½ cup	1.6
Oatmeal, fortified, cooked	1 cup	8.0	Asparagus	½ cup	1.5
Bagel	1	1.7			
English muffin	1	1.6			

Phosphorous

Food	Amount	Phosphorous (mg)	Food	Amount	Phosphorous (mg)
Milk and milk products:			**Grains:**		
Yogurt	1 cup	327	Bran flakes	1 cup	180
Skim milk	1 cup	250	Shredded wheat	2 large biscuits	81
Whole milk	1 cup	250	Whole wheat bread	1 slice	52
Cottage cheese	½ cup	150	Noodles, cooked	½ cup	47
American cheese	1 oz	130	Rice, cooked	½ cup	29
Meats:			White bread	1 slice	24
Pork	3 oz	275	**Vegetables:**		
Hamburger	3 oz	165	Potato	1 medium	101
Tuna	3 oz	162	Corn	½ cup	73
Lobster	3 oz	125	Peas	½ cup	70
Chicken	3 oz	120	French fries	½ cup	61
Nuts and seeds:			Broccoli	½ cup	54
Sunflower seeds	¼ cup	319	**Other:**		
Peanuts	¼ cup	141	Milk chocolate	1 oz	66
Pine nuts	¼ cup	106	Cola	12 oz	51
Peanut butter	1 Tbsp	61	Diet cola	12 oz	45

Potassium

Food	Amount	Potassium (mg)	Food	Amount	Potassium (mg)
Vegetables:			Broccoli	1/2 cup	205
Potato	1 medium	780	**Fruits:**		
Winter squash	½ cup	327	Avocado	½ medium	680
Tomato	1 medium	300	Orange juice	1 cup	469
Celery	1 stalk	270	Banana	1 medium	440
Carrots	1 medium	245	Raisins	¼ cup	370

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Table 1.14 Food sources of minerals (continued)

Potassium					
Food	**Amount**	**Potassium (mg)**	**Food**	**Amount**	**Potassium (mg)**
Prunes	4 large	300	Bran flakes	1 cup	248
Watermelon	1 cup	158	Raisin bran	1 cup	242
Meats:			Wheat flakes	1 cup	96
Fish	3 oz	500	**Milk and milk products:**		
Hamburger	3 oz	480	Yogurt	1 cup	531
Lamb	3 oz	382	Skim milk	1 cup	400
Pork	3 oz	335	Whole milk	1 cup	370
Chicken	3 oz	208	**Other:**		
Grains:			Salt substitutes	1 tsp	1,300–2,378
Bran buds	1 cup	1080			
Fluoride					
Food	**Amount**	**Fluoride (mg)**	**Food**	**Amount**	**Fluoride (mg)**
Grape juice, white	6 oz	350	French fries, McDonald's	1 medium	130
Instant tea	1 cup	335	Dannon's Fluoride to Go	8 oz	178
Raisins	3½ oz	234	Municipal water, U.S.	8 oz	186
Wine, white	3½ oz	202	Bottled water, store brand	8 oz	37
Wine, red	3½ oz	105	Iodized salt	1 tsp	400
Iodine					
Food	**Amount**	**Iodine (mcg)**	**Food**	**Amount**	**Iodine (mcg)**
Haddock	3 oz	125	Cottage cheese	½ cup	50
Cod	3 oz	87	Egg	1	22
Shrimp	3 oz	30	Cheddar cheese	1 oz	17
Bread	1 oz (1 slice)	35–142			

[a]Actually, the richest source of calcium is alligator meat; 3½ ounces contain about 1,231 milligrams of calcium, but just try to find it on your grocer's shelf!

Each nutrient has a range of intake levels that corresponds to optimum functioning of that nutrient (Figure 1.6). Intake levels below and above this range are associated with impaired functions.

Inadequate intake of an essential nutrient, if prolonged, results in obvious deficiency diseases. Marginally deficient diets produce subtle changes in behavior or physical condition. If the optimal intake range is exceeded (usually by overdoses of supplements), mild to severe changes in mental and physical functions occur, depending on the amount of the excess and the nutrient involved. Overt vitamin C deficiency, for example, produces irritability, bleeding gums, pain upon being touched, and failure of bone growth. Marginal deficiency may cause delayed wound healing. The length of time a deficiency or toxicity takes to develop depends on the type and amount of the nutrient consumed and the extent of body nutrient reserves. Intakes of 32 mg/day of vitamin C, or about one-third of the RDA for adults (75 mg and 90 mg per day for women and men, respectively), lower blood vitamin C levels to the deficient state within 3 weeks. On the excessive side, too much supplemental vitamin C causes diarrhea and increases the risk of kidney stone formation.[28,29,30] For nutrients, enough is as good as a feast.

Steps in the Development of Nutrient Deficiencies and Toxicities

Poor nutrition due to inadequate diet generally develops in the stages outlined in Figure 1.7.

After a period of deficient intake of an essential nutrient, tissue reserves become depleted, and subsequently, blood levels of the nutrient decline. When the blood level can no longer supply cells with optimal amounts of nutrients, cell processes change. These changes have a negative effect on the cell's ability to form proteins appropriately, regulate energy formation and use, protect itself from oxidation, or carry out other normal functions. If the deficiency continues, groups of cells malfunction, which leads to problems related to tissue and organ functions. Physical signs of the deficiency may then develop, such as growth failure with protein deficiency or an inability to walk as a result of beriberi (thiamin deficiency). Eventually, some problems produced by the deficiency can no longer be reversed by increased nutrient intake. Blindness that results from serious vitamin A deficiency, for example, is irreversible.

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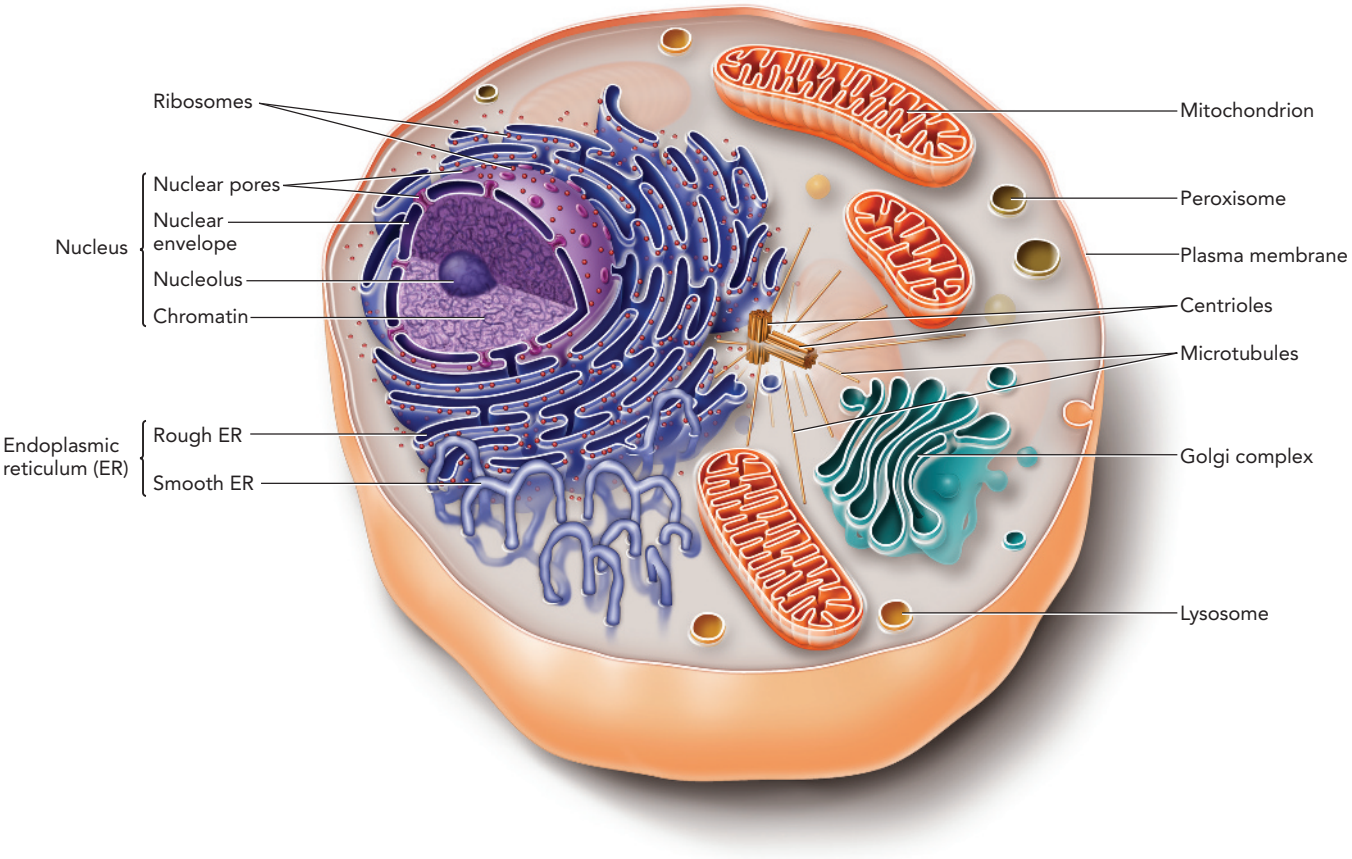


Figure 1.5 Schematic representation of the structure and major components of a human cell.

Excessively high intakes of many essential nutrients produce toxicity diseases. Excessive vitamin A, for example, produces hypervitaminosis A, and selenium overdose leads to selenosis. Signs of toxicity stem from an increased level of the nutrient in the blood and the subsequent oversupply of the nutrient to cells. The high nutrient load upsets the balance needed for optimal cell function. These changes in cell function lead to the signs and symptoms of a toxicity disease.

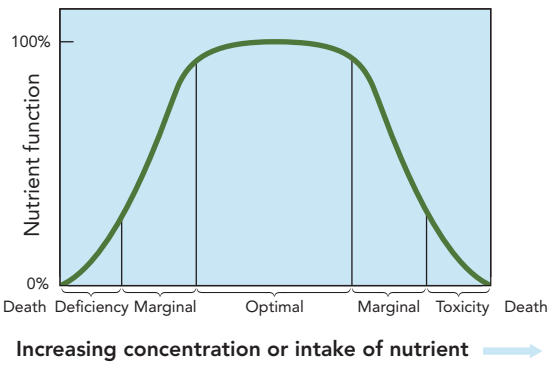


Figure 1.6 Nutrient function and consequences by level of intake.

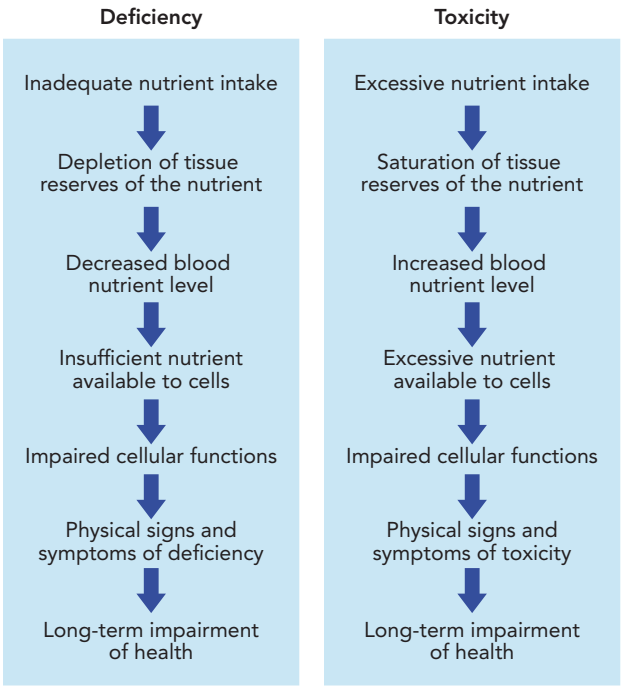


Figure 1.7 Usual steps in the development of nutrient deficiencies and toxicities.

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For both deficiency and toxicity diseases, the best way to correct the problem is at the level of intake. Identifying and fixing intake problems prevents related health problems from developing.

Nutrient Deficiencies Are Usually Multiple Most foods contain many nutrients, so poor diets are generally inadequate in a number of nutrients. Calcium and vitamin D, for example, are present in milk. Deficiencies of both of these nutrients may develop from a low milk intake and an otherwise poor diet.

The "Ripple Effect" Dietary changes affect the level of intake of many nutrients. Switching from a high-fat to a low-fat diet, for instance, may result in a lower intake of calories and higher intake of dietary fiber and vitamins. Consequently, dietary changes introduced for the purpose of improving intake of a particular nutrient produce a "ripple effect" on the intake of other nutrients.

Nutrition Principle 5

Humans have adaptive mechanisms for managing fluctuations in food intake.

Healthy humans have adaptive mechanisms that partially protect the body from poor health due to fluctuations in nutrient intake. These mechanisms act to conserve nutrients when dietary supply is low and to eliminate them when excessively high amounts are present. Dietary surpluses of nutrients such as iron, calcium, vitamin A, and vitamin B_{12} are stored within tissues for later use. In the case of iron and calcium, absorption is also regulated so that the amount absorbed changes in response to the body's need for these nutrients. The body has a low storage capacity for other nutrients, such as vitamin C and water, and excesses are eliminated through urine or stools. Fluctuations in energy intake are primarily regulated by changes in appetite. If too few calories are consumed, however, the body will obtain energy from its glycogen and fat stores. If caloric intakes remain low and a significant amount of body weight is lost, the body down-regulates its need for energy by lowering body temperature and the capacity for physical work. When energy intake exceeds need, the extra is converted to fat—and to a lesser extent, to glycogen—and stored for later use.

Nutrition Principle 6

Malnutrition can result from poor diets and from disease states, genetic factors, or combinations of these causes.

Malnutrition **Malnutrition** means "poor nutrition" and results from either inadequate or excessive availability of energy or nutrients within cells. Niacin toxicity, obesity, and iron deficiency are examples of malnutrition.

In Focus Nutrigenomics

Definition: The study of nutrient–gene interactions and the effects of these interactions on health. Also called nutritional genomics.

Nutrigenomics covers the study of the effects of genes on how the body uses nutrients and the ways in which dietary components affect gene expression, function, and health status.

As our understanding of the specific influences of food components on genes, gene functions, and health through the life cycle progresses, nutritional advice will become individualized based on knowledge of a person's genetic makeup.

Malnutrition can result from poor diets as well as from diseases that interfere with the body's ability to use the nutrients consumed. **Primary malnutrition** results when a poor nutritional state is dietary in origin. **Secondary malnutrition**, on the other hand, is precipitated by a disease state, surgical procedure, or medication. Diarrhea, alcoholism, AIDS, and gastrointestinal tract bleeding are examples of conditions that may cause secondary malnutrition.

Nutrient–Gene Interactions Advances in knowledge about nutrient–gene interactions in health and disease are revolutionizing the science and practice of nutrition. This new field of nutrition science is called **nutrigenomics** and is highlighted in the "In Focus" box. Genes provide the codes for enzyme and other protein synthesis, and they consequently affect body functions in a huge number of ways. Although individuals are 99.9 percent genetically identical, the 0.1 percent difference in genetic codes makes everyone unique. Variations in gene types (or genotypes) contribute to disease resistance and development, and to the way individuals respond to various drugs.[31,32,33]

malnutrition The cellular imbalance between the supply of nutrients and energy and the body's demand for them to ensure growth, maintenance, and specific functions.

primary malnutrition Malnutrition that results directly from inadequate or excessive dietary intake of energy or nutrients.

secondary malnutrition Malnutrition that results from a condition (e.g., disease, surgical procedure, medication use) rather than primarily from dietary intake.

nutrigenomics The study of diet- and nutrient-related functions and interactions of genes and their effects on health and disease.

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Thousands of rare diseases related to a defect in a single gene have been identified, and many of these affect nutrient needs. Such defects can alter the absorption or utilization of nutrients such as amino acids, iron, zinc, and the vitamins B_{12}, B_6, or folate. Phenylketonuria (PKU), galactosemia, and hemochromatosis are three examples of single-gene defects that substantially affect nutrient needs or utilization (Table 1.15).[34,35,36]

Most diseases related to genetic traits are not as well defined as are single-gene defects. They are more likely to represent an interwoven mesh of multiple gene variants and environmental factors.

Food and nutrient intake is a prominent environmental factor that interacts with genotype and gene function. Lack of adequate nutrition during pregnancy, for example, can program gene functions for life in ways that increase or decrease the risk of chronic disease development.[37] Throughout life, components of foods consumed affect gene function by turning specific genes "on" or "off," thereby affecting what metabolic reactions occur within the body. Newly identified relationships between dietary components and genes are being announced regularly. Here are a few examples of effects of nutrient–gene interactions on health status:

- Consumption of high glycemic index carbohydrates appears to increase the risk of type 2 diabetes in individuals with a certain form of a gene involved in insulin production and secretion.[38]
- High alcohol intake during pregnancy in some women sharply increases the risk of fetal alcohol syndrome, but the fetuses of other females with different genetic traits are not affected by high alcohol intake.[39]
- Regular consumption of green tea reduces the risk of prostate cancer in certain individuals with particular genetic traits.[40]

Genetic factors alone cannot explain the rapid rise in obesity and type 2 diabetes in the United States, but they do provide clues about needed preventive and therapeutic measures.

chronic disease Slow-developing, long-lasting diseases that are not contagious (e.g., heart disease, cancer, diabetes) and are the result of a combination of genetic, physiological, environmental, and behavioral factors; also known as "noncommunicable diseases."

hypertension High blood pressure. It is defined in adults as blood pressure exerted inside blood vessel walls that typically exceeds 140/90 mm Hg (millimeters of mercury).

Nutrition Principle 7

Some groups of people are at higher risk of becoming inadequately nourished than others.

Females who are pregnant or breastfeeding, infants, children, people who are ill, and frail older adults have a greater need for nutrients than healthy adults do. As a result, they are at higher risk of becoming inadequately nourished than others. Within these groups, those at highest risk of nutritional insults are those with a low income. In cases of widespread food shortages, such as those induced by war or natural disaster, the health of these nutritionally vulnerable groups is compromised the soonest and the most.

Nutrition Principle 8

Poor nutrition can influence the development of certain chronic diseases.

Shared Dietary Risk Factors Today, the major causes of death among Americans are slow-developing, lifestyle-related **chronic diseases** (Photo 1.1). Based on the 2018 National Health Interview Survey (NHIS), 51.8 percent of Americans (129 million adults) had been diagnosed with one of 10 chronic conditions such as diabetes, heart disease, hypertension, cancer, stroke, asthma, arthritis, weak or failing kidneys, chronic obstructive pulmonary disease (COPD), and/or chronic bronchitis in the past 12 months, The survey documented 24.6 percent (61 million adults) had at least one chronic condition and the percentage of adults with two or more chronic conditions was 27.2 percent (68 million).[41] **hypertension**

The leading causes of death among Americans are heart disease and cancer. Together they account for 37 percent

Table 1.15 Examples of single-gene disorders that affect nutrient need[35,36]

PKU (phenylketonuria)	A rare disorder caused by the lack of the enzyme phenylalanine hydroxylase. Lack of this enzyme causes phenylalanine, an essential amino acid, to build up in the blood. High blood levels of phenylalanine during growth lead intellectual disability, poor growth, and other problems. PKU is treated by low-phenylalanine diets.
Galactosemia	Galactosemia is a single-gene-defect disorder that interferes with the body's utilization of the sugar galactose found in lactose ("milk sugar"). The signs and symptoms of galactosemia result from an inability to use galactose to produce energy. If infants with classic galactosemia are not treated promptly with a low-galactose diet, life-threatening complications appear within a few days after birth. People with this condition must avoid all milk, milk-containing products (including dry milk), and other foods that contain galactose for life. It occurs in approximately 1 in 30,000 to 60,000 newborns.
Hemochromatosis	A single-gene defect disorder affecting 1 in 300 and occurring most commonly in European Americans. It is caused by a defect in a gene that produces a protein that controls how much iron is absorbed from food. Individuals with hemochromatosis absorb more iron than normal and have excessive levels of body iron. High levels of body iron have toxic effects on tissues such as the liver and heart. Hemochromatosis is treated with medications and a low-iron and vitamin C diet. A high intake of vitamin C can make hemochromatosis worse because vitamin C increases the absorption of iron.

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Photo 1.1 Poor nutrition increases the risk of many chronic diseases.

of all deaths.[42] Western-type dietary patterns high in food sources of saturated fats, *trans* fats, sugars, and sodium, and low in vegetables, fruits, legumes, and whole grain products are linked to the development of heart disease, obesity, and type 2 diabetes.[13] Six types of cancer, including colon, pancreatic, and breast cancer, are related to obesity, habitually low intakes of vegetables and fruits, and high levels of intake of processed meats.[43]

Diet is related to three other leading causes of death: diabetes, **stroke**, and **Alzheimer's disease**. Examples of relationships between diseases and disorders and diet are overviewed in Table 1.16.[43-52] A number of these diseases and disorders share the common dietary risk factors of low intakes of vegetables, fruits, and whole grains; and excess calorie and sugar intake. These risk factors are associated with the development of **chronic inflammation** and **oxidative stress**, conditions that are strongly related to the development of chronic diseases.[13,50-52]

Inadequate and excessive nutrient intakes may contribute to the development of more than one disease and produce disease by more than one mechanism. The effects of habitually poor diets on chronic disease development often take years to become apparent.

Nutrition Principle 9

Adequacy, variety, and balance are key characteristics of healthy dietary patterns.

stroke An event that occurs when a blood vessel in the brain ruptures or becomes blocked. Stroke is often associated with "hardening of the arteries" in the brain. Also called cerebral vascular accident.

Alzheimer's disease A brain disease that represents the most common form of dementia. It is characterized by memory loss for recent events that expands to more distant memories over the course of 5 to 10 years. It eventually produces profound intellectual decline characterized by dementia and personal helplessness.

chronic inflammation Low-grade inflammation that lasts weeks, months, or years. Inflammation is the first response of the body's immune system to infectious agents, toxins, or irritants. It triggers the release of biologically active substances that promote oxidation and other reactions to counteract the infection, toxin, or irritant. A side effect of chronic inflammation is that it also damages lipids, cells, and tissues.

oxidative stress A condition that occurs when cells are exposed to more oxidizing molecules (such as free radicals) than to antioxidant molecules that neutralize them. Over time, oxidative stress causes damage to lipids, DNA, cells, and tissues. It increases the risk of heart disease, type 2 diabetes, cancer, and other diseases.

Table 1.16 Examples of diseases and disorders linked to diet[43–45,47–52]

Disease or Disorder	Dietary Connections
Heart disease	Excessive body fat, high intakes of *trans* fat, added sugar, and salt; low vegetable, fruit, fish, nuts, and whole grain intakes
Cancer	Low vegetable and fruit intakes; excessive body fat and alcohol intake; regular consumption of processed meats
Stroke	Low vegetable and fruit intake; excessive alcohol intake; high animal-fat diets
Diabetes (type 2)	Excessive body fat; low vegetable, whole grain, and fruit intake; high added sugar intake
Cirrhosis of the liver	Excessive alcohol consumption; poor overall diet
Hypertension	Excessive sodium (salt) and low potassium intake, excess alcohol intake; low vegetable and fruit intake; excessive levels of body fat
Iron-deficiency anemia	Low iron intake
Tooth decay and gum disease	Excessive and frequent sugar consumption; inadequate fluoride intake
Osteoporosis	Inadequate calcium and vitamin D, low intakes of vegetables and fruits
Obesity and overweight	Excessive calorie intake, overconsumption of energy-dense, nutrient-poor foods
Chronic inflammation and oxidative stress	Excessive calorie intake; excessive body fat; high animal-fat diets; low intake of whole grains, vegetables, fruit, and fish
Alzheimer's disease	Regular intake of high-fat animal products; low intake of olive oil, vegetables, fruits, fish, wine, and whole grains

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Healthy Dietary Patterns Healthy diets correspond to a dietary pattern associated with normal growth and development, a healthy body weight, health maintenance, and disease prevention. One such pattern is represented by the USDA's MyPlate food group intake plan. Several other types of dietary patterns, including the Healthy Mediterranean-Style Dietary Pattern and the Healthy U.S.-Style Dietary Pattern, have also been found to promote health and foster disease prevention.[13] Healthy dietary patterns are characterized by the regular consumption of moderate portions of a variety of foods from each of the basic food groups. No specific foods or food preparation techniques are excluded in a healthy dietary pattern.

Healthy dietary patterns are plant-food based and include the regular consumption of vegetables, fruits, dried beans, fish and seafood, low-fat dairy products, poultry and lean meats, nuts and seeds, and whole grains. Dietary patterns that include large or frequent servings of foods containing high amounts of *trans* fat, added sugars, salt, or alcohol miss the healthy dietary pattern mark. Healthy dietary patterns supply needed nutrients and beneficial phytochemicals through food rather than through supplements or special dietary products.[52]

Energy and Nutrient Density Most Americans consume more calories than needed, become overweight as a result, *and* consume inadequate diets. This situation is partly due to overconsumption of **energy-dense foods** such as processed and high-fat meats, chips, candy, many desserts, and full-fat dairy products. Energy-dense foods have relatively high-calorie values per unit weight of the food. Intake of energy-dense diets is related to the consumption of excess calories and to the development of overweight and diabetes.[13]

Many energy-dense foods are nutrient poor, or contain low levels of nutrients given their caloric value. These foods are sometimes referred to as **empty-calorie foods** and include products such as soft drinks, sherbet, hard candy, alcohol, and cheese twists. Excess intake of energy-dense and empty-calorie foods increases the likelihood that calorie needs will be met or exceeded before nutrients needs are met. Diets most likely to meet nutrient requirements without exceeding calorie needs contain primarily **nutrient-dense foods**, or foods with high levels of nutrients and relatively low calorie value. Nutrient-dense foods such as nonfat milk and yogurt, lean meat, dried beans, vegetables, and fruits provide relatively high amounts of nutrients compared to their calorie value.[13]

energy-dense foods Foods that have relatively high-calorie values per unit weight of the food.

empty-calorie foods Foods that provide an excess of calories relative to their nutrient content.

nutrient-dense foods Foods that contain relatively high amounts of nutrients compared to their caloric value.

dietary supplements Any product intended to supplement the diet, including vitamin and mineral supplements, proteins, enzymes, amino acids, fish oils, fatty acids, hormones and hormone precursors, and herbs and other plant extracts. In the United States, such products must be labeled "Dietary Supplement."

Nutrition Principle 10

There are no "good" or "bad" foods.

People tend to classify foods as being "good" or "bad," but such opinions about individual foods oversimplify the potential contribution of these foods to a diet.[52] Although opinions about which foods are good or bad vary, hot dogs, ice cream, candy, bacon, and French fries are often judged to be bad, whereas vegetables, fruits, and whole-grain products are given the "good" stamp. Unless we're talking about spoiled stew, poisonous mushrooms, or something similar, however, no food can be firmly labeled as good or bad. Ice cream can be a "good" food for physically active, normal-weight individuals with high calorie needs who have otherwise met their nutrient requirements by consuming nutrient-dense foods. Some people who only eat what they consider to be "good" foods, like vegetables, fruits, whole grains, and tofu, may still miss the healthful diet mark due to inadequate consumption of essential fatty acids and certain vitamins and minerals. All foods can fit into a healthful diet as long as nutrient needs are met at calorie-intake levels that maintain a healthy body weight.[52]

1.2 Nutrition Labeling

In 1990, the U.S. Congress passed legislation establishing requirements for nutrition information, nutrient content claims, and health claims presented on food and dietary supplement labels. This legislation, called the Nutrition Labeling and Education Act, requires that almost all multiple-ingredient foods and **dietary supplements** be labeled with a Nutrition Facts panel (Figure 1.8). The act also requires that nutrient content and health claims appearing on package labels, such as "*trans* fat–free" and "helps prevent cancer," qualify based on criteria established by the FDA.

Concern about rising rates of overweight and type 2 diabetes among children and youth prompted senators in the United States to propose national menu labeling standards for fast food and other restaurants in 2009. Legislation passed in 2011 requires restaurant chains with 20 or more outlets to post calories on menus or menu boards and make additional information about the fat, saturated fat, carbohydrate, sodium, protein, and fiber content available in writing upon request. In 2016, the Nutrition Facts label on packaged food was updated. Serving sizes and calories have been bolded with a larger font size to make them easier to find. Other changes included updates to daily values and the addition of added sugars, vitamin D, and potassium. These changes were made based on public feedback and from updated nutrition research and scientific information.[53]

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Original Label

Nutrition Facts

Serving Size 2/3 cup (55g)
Servings Per Container 8

Amount Per Serving

Calories 230 Calories from Fat 72

	% Daily Value*
Total Fat 8g	**12%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**12%**
Dietary Fiber 4g	**16%**
Sugars 12g	
Protein 3g	
Vitamin A	10%
Vitamin C	8%
Calcium	20%
Iron	45%

* Percent Daily Values are based on a 2,000 calorie diet. Your daily value may be higher or lower depending on your calorie needs.

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

New Label

Nutrition Facts

8 servings per container
Serving size **2/3 cup (55g)**

Amount per serving
Calories **230**

	% Daily Value*
Total Fat 8g	**10%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**13%**
Dietary Fiber 4g	**14%**
Total Sugars 12g	
Includes 10g Added Sugars	**20%**
Protein 3g	
Vitamin D 2mcg	10%
Calcium 260mg	20%
Iron 8mg	45%
Potassium 240mg	6%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

1. The serving size now appears in larger, bold font and some serving sizes have been updated.
2. Calories are now displayed in larger, bolder font.
3. Daily Values have been updated.
4. Added sugars, vitamin D, and potassium are now listed. Manufacturers must declare the amount in addition to percent Daily Value for vitamins and minerals.

Figure 1.8 Example of a Nutrition Facts panel. The existing (left) and the current Nutrition Facts panels (right).
Source: Available at www.fda.gov/downloads/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/LabelingNutrition/.pdf, and can be found as Ill. 4.14 on pp. 4-12 in NN8e.

Nutrition Facts Panel

For foods, the Nutrition Facts panel must list the content of fat, saturated fat, *trans* fat, cholesterol, sodium, total carbohydrates, fiber, sugars, protein, vitamins, calcium, and iron in a standard serving. Additional nutrients may be listed on a voluntary basis. If a health claim about a particular nutrient is made for the product, the product's content of the nutrient addressed in the claim must be shown. Nutrition Facts panels contain a column that lists the percentage Daily Value (% DV) for each relevant nutrient. This information helps consumers decide, for example, whether the carbohydrate content of a serving of a specific food product is a lot or a little.

Nutrient content claims made on food package labels must meet specific criteria. Products labeled "no *trans* fat" or "*trans* fat–free," for example, must contain less than 0.5 g of *trans* fat and of saturated fat. Products labeled "low sodium" must contain less than 140 mg of sodium per serving.

Ingredient Label

Food products must list ingredients in an "ingredient label." The list must begin with the ingredient that contributes the greatest amount of weight to the product and continue with the other ingredients on a weight basis.

The FDA now requires that ingredient labels note the presence of common food allergens in products. Potential food allergens that must be listed are milk, eggs, fish, shellfish, tree nuts, wheat, peanuts, and soybeans. These eight foods account for 90 percent of food allergies.

Dietary Supplement Labeling

Dietary supplements such as herbs, amino acid pills and powders, and vitamin and mineral supplements must show a "Supplement Facts" panel that lists serving size, ingredients, and % DV of essential nutrients contained. Because they do not have to be shown to be safe and effective before they are sold, labels on dietary supplements cannot claim to treat, cure, or prevent disease. They can be labeled with standardized nutrition content claims such as "high in calcium" or "a good source of fiber." They can also be labeled with health claims such as "may reduce the risk of heart disease" if the product qualifies based on nutrition labeling requirements. Dietary supplements can make other claims on product labels not approved by the FDA, such as "supports the immune system" or "helps maintain mental health," as long as the label doesn't state or imply that the product will prevent, cure, or treat disease. If a health claim is made on a dietary supplement label, the label also must present the FDA disclaimer:

> This product has not been evaluated by the FDA. This product is not intended to diagnose, treat, cure, or prevent any disease.

Enrichment and Fortification Some foods are labeled as "enriched" or "fortified." These two terms have specific

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definitions. **Enrichment** pertains only to refined grain products and covers some of the vitamins and one of the minerals lost when grains are refined. By law, producers of bread, cornmeal, crackers, flour tortillas, white rice, and other products made with refined grains must use flours enriched with thiamin, riboflavin, niacin, and iron.

Any food can be fortified with added vitamins and minerals, and its manufacturers most often do so on a voluntary basis to enhance product sales. However, some foods must be fortified. Refined grain flours must be fortified with folic acid, milk with vitamin D, and low-fat and skim milk with vitamins D and A. Although fortification is not required for salt, it is often fortified with iodine. **Fortification** of these foods has contributed substantially to reductions in the incidence of diseases related to inadequate intakes.[54]

Herbal Remedies

The FDA considers herbal products to be dietary supplements; they are taken by many people during various stages of the life cycle. Thousands of types of herbal products are available (Photo 1.2). Some herbal remedies act like drugs and have side effects, but they are not considered to be drugs and are loosely regulated. They do not have to be shown to be safe or effective before they are marketed. Herbs vary substantially in safety and effectiveness—they can have positive, negative, or neutral effects on health. Knowledge of the effects of herbal remedies is far from complete, making it difficult to determine appropriateness of their use in many cases. The extent to which herbs pose a risk to health depends on the amount taken, the duration of use, and the user's age, life cycle stage, and health status.

Prebiotics and Probiotics The terms *prebiotics* and *probiotics* were derived from *antibiotics* due to their probable effects on increasing resistance to various diseases. Prebiotics and probiotics are in a class of functional foods by themselves. **Prebiotics** are fiberlike, indigestible carbohydrates that are broken down by bacteria in the colon. The breakdown products foster the growth of beneficial bacteria. The digestive tract generally contains over 500 species of microorganisms and 100 trillion bacteria. Some species of bacteria such as *E. coli* 0157:H7 may cause disease; others, such as strains of lactobacillus and bifidobacteria, may help prevent certain diseases.[55,56] Because they foster the growth of beneficial bacteria, prebiotics are considered "intestinal fertilizer." **Probiotic** is the term for live, beneficial ("friendly") bacteria that enter food products during fermentation and aging processes. Those that survive digestive enzymes and acids may start colonies of beneficial bacteria in the digestive tract. Table 1.17 lists foods and other sources of pre- and probiotics.

Prebiotics and probiotics have been credited with important benefits, such as the prevention and treatment of diarrhea and other infections in the gastrointestinal tract; prevention of colon cancer; decreased blood levels of triglycerides, cholesterol, and glucose; and decreased dental caries.[57] Prebiotics appear to be safe in general; however, probiotics may be harmful to specific individuals who may develop blood infections.[58] The primary side effects associated with prebiotic and probiotic use are flatulence, bloating, and constipation.[57]

Availability of foods containing prebiotics and probiotics is much more common in Japan and European countries than in Canada or the United States. However, availability of such products is increasing in these countries as research results shed light on their safety and effectiveness.[47]



Barry Austin/Photodisc/Getty Images

Photo 1.2 Herbal products are widely available on the market.

enrichment The replacement of thiamin, riboflavin, niacin, and iron lost when grains are refined.

fortification The addition of one or more vitamins or minerals to a food product.

prebiotics Certain fiberlike forms of indigestible carbohydrates that support the growth of beneficial bacteria in the lower intestine. Nicknamed "intestinal fertilizer."

probiotics Strains of lactobacillus and bifidobacteria that have beneficial effects on the body. Also called "friendly bacteria."

1.3 The Life-Course Approach to Nutrition and Health

Nutritional needs should be met at every stage of the life cycle because nutritional status at one stage influences the health status in the next ones. Lack of adequate nutrition during pregnancy, for example, can program gene functions for

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Table 1.17 Food and other sources of prebiotics and probiotics

Probiotics
Fermented or aged milk and milk products
• Yogurt with live culture
• Buttermilk
• Kefir
• Cottage cheese
• Dairy spreads with added inulin
Other fermented products
• Soy sauce
• Tempeh
• Fresh sauerkraut
• Miso
Breast milk
Probiotic tablets, powders, and nutritional beverages
Prebiotics
Chicory
Jerusalem artichokes
Wheat
Barley
Rye
Onions
Garlic
Leeks
Prebiotic tablets, powders, and nutritional beverages
Bananas
Asparagus
Dandelion greens

life in ways that set the stage for lifelong metabolic changes that increase the risk of chronic-disease development. Iron deficiency experienced by young children can decrease intellectual capacity later in life, and adequate vitamin D status during adolescence and early adulthood decreases the risk of breast cancer in older women.[59] Disease prevention and health promotion, rather than repair of health problems, requires a focus on meeting nutritional and other health needs of individuals during every stage of the life cycle.

Meeting Nutritional Needs Across the Life Cycle

Healthy individuals require the same nutrients throughout life, but amounts of nutrients needed vary based on age, growth, and development. Nutrient needs during each stage of the life cycle can be met through a variety of foods and food practices. There is no one best diet for everyone. Traditional diets defined by diverse cultures and religions provide the foundation for meeting individuals' nutritional needs and the framework for dietary modification when needed.[13,60] Although it is inaccurate to say that all or most members of a particular cultural group or religion follow the same dietary practices, groups of individuals may share common beliefs about food and food-intake practices.

Dietary Considerations Based on Country of Origin

People immigrating to the United States and other countries preserve dietary traditions of their culture and integrate cross-cultural adaptations into their dietary practices. The extent to which culturally based food habits change depends to some extent on income, food cost, and food availability. Families of Hispanic ethnicity immigrating from El Salvador who live in urban areas of the United States, for example, maintain many cultural food practices from their homeland:

- Breakfast may consist of fried beans, corn tortillas, occasionally eggs, and sweetened coffee with boiled milk.
- Lunch may consist of soup, fried meat, rice or rice with vegetables, corn tortillas, and fruit juice.
- Dinner may offer fried beef or chicken, corn tortillas, rice, dried beans, fruit juice, and black coffee.

Cross-cultural adaptations made by a portion of individuals of Hispanic ethnicity from El Salvador immigrating to the United States include the addition of French fries, hamburgers, American cheeses, salad dressing, tacos, flour tortillas, and peanut butter to their diets.[61,62]

As populations become more diverse, so do their diets. A primary example of this phenomenon is represented by changes in traditional dietary practices of Native Americans. In general, traditional diets of Native Americans in the United States consisted of foods such as buffalo, deer, wild berries and other fruits, corn, turnips, squash, wild potato, and wild rice. Loss of land and bison, discrimination, poverty, and food programs that offered refined flour, sugar, salt pork, and other high-fat meats drastically changed what Native American people ate, how they lived, and their health status. Activities aimed at bringing back traditional foods and dietary practices are under way among many Native American groups.[63]

Food preferences of individuals who are Black vary widely but may stem from their cultural food heritage. Historically important foods include corn bread, pork, buttermilk, rice, sweet potatoes, greens, cabbage, salt pork, and fried fish. These "soul foods" make up less of their diet now than in the past but remain foods of choice for special occasions.[62,64]

Dietary Considerations Based on Religion

Many religions have special dietary laws and practices. For example:

- Some individuals who practice Hinduism may not consume foods such as garlic and onions, which are believed to hinder spiritual development.
- Individuals who practice Buddhism in certain countries tend to be vegetarian or to eat fish as their only choice of meat. In countries such as Tibet and Japan, vegetarianism is rarely practiced among individuals following Buddhism.
- Alcohol is prohibited as part of Sikhism, and meat prepared by kosher or halal methods is avoided.

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- The Church of Jesus Christ of Latter Day Saints prohibits alcohol and discourages consumption of caffeine, coffee and tea (hot drinks). Members of the Church of Jesus Christ of Latter Day Saints eat fruits and vegetables and grains such as oats, rice and wheat. Meat is to be consumed sparingly.
- Members of Seventh-Day Adventist Churches tend to follow a strict lacto-ovo vegetarian diet and exclude alcohol and caffeine. Whole grains, vegetables, and fruits are considered the base of diets, and dried beans, low-fat dairy products, and eggs may be consumed infrequently.
- Jewish dietary laws require that foods consumed must be kosher, or fit to eat according to Judaic law. Organizations are certified as supplying foods that are kosher. The Jewish calendar includes six fasting days that call for total abstinence from food or drink.
- The Islamic religion has dietary laws that require foods to be halal, or permitted for consumption by Muslims. Pork consumption is not allowed, nor is the consumption of animals slaughtered in the name of any god other than Allah. Slaughterhouses must be under the supervision of a halal certifier in order for meat to be considered fit to eat, although some Muslims will eat other meats. Consuming alcohol is prohibited.[64]

Additional information about cultural and religious food practices and beliefs can be obtained directly by getting to know people from a variety of cultures and their dietary preferences. This information can be of great benefit in nutrition education and counseling situations.

1.4 Nutrition Assessment

Nutrition assessment of groups and individuals is a prerequisite to planning for the prevention or solution of nutrition-related health problems. It represents a broad area within the field of nutrition and is highlighted here.

Nutritional status may be assessed for a population group or for an individual. Community-level assessment identifies a population's status using broad nutrition and health indicators, whereas individual assessment provides the baseline for anticipatory guidance and nutrition intervention.

Community-Level Assessment

A target community's "state of nutritional health" can generally be estimated using existing vital statistics data, seeking the opinions of target group members and local health experts, and making observations. Knowledge of average household incomes; the proportion of families participating in SNAP (formerly called the Food Stamp Program), soup kitchens, school breakfast programs, or food banks; and the age distribution of the group can help identify key nutrition concerns and issues. In large communities, rates of infant mortality, heart disease, and cancer can reveal whether the incidence of these problems is unusually high.

Information gathered from community-level nutrition assessment can be used to develop community-wide programs addressing specific problem areas, such as childhood obesity or iron-deficiency anemia. Nutrition programs should be integrated into community-based health programs.

registered dietitian nutritionist (RDN)
An individual who has acquired food and nutrition knowledge and skills necessary to pass a national registration examination and who participates in continuing professional education.

Individual-Level Nutrition Assessment

Nutrition assessment of individuals has four major components:

1. Clinical/physical assessment
2. Dietary assessment
3. Anthropometric assessment
4. Biochemical assessment

Data from all of these areas are needed to describe a person's nutritional status. Data on height and weight provide information on weight status, for example, and knowledge of blood iron levels tells you something about iron status. It cannot be concluded that people who are normal weight or have good iron status are "well nourished." Single measures do not describe a person's nutritional status.

Clinical/Physical Assessment

A clinical/physical assessment involves visual inspection of a person by a trained **registered dietitian nutritionist** (**RDN**) or other qualified professional to note features that may be related to malnutrition. Excessive or inadequate body fat, paleness, bruises, and brittle hair are examples of features that may suggest nutrition-related problems. Physical characteristics are nonspecific indicators, but they can support other findings related to nutritional status. They cannot be used as the sole criterion upon which to base a decision about the presence or absence of a particular nutrition problem.

Dietary Assessment

Many methods are used for assessing dietary intake. For clinical purposes, computerized 24-hour dietary recalls and food records are most common. Single 24-hour recalls and food frequency questionnaires are most useful for estimating dietary intakes for groups, whereas multiple recalls and dietary histories are generally used for assessments of individual diets.

24-Hour Dietary Recalls and Records Becoming proficient at administering 24-hour recalls takes training and practice. Food records, on the other hand, are completed by clients themselves. These are more accurate if the client has also received some training. Generally, the purpose of assessing an individual's diet is to estimate the person's

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overall diet quality so that strengths and weaknesses can be identified, or to assess intake of specific nutrients that may be involved in disease states. Information on multiple days of dietary intake is needed to obtain a reliable estimate of intake by food group, calories, and nutrients.[65]

Dietary History Dietary histories have been used for decades and represent a quantitative method of dietary assessment. They require an interview by a trained professional that is about 1½ hours long and includes a 24-hour dietary recall modified to represent usual intake, careful deliberations over food types and portions, and a cross-check food frequency questionnaire that confirms 24-hour usual dietary intake information. Results must be coded, checked, and processed. Although expensive, diet histories provide more complete and accurate data than most other dietary assessment methods.[65]

Food Frequency Questionnaires Food frequency questionnaires are often used in epidemiological studies to estimate food and nutrient intake of groups of people. These tools are considered semiquantitative because they force people into describing food intake based on a limited number of food choices and portion sizes (Figure 1.9). Validated food frequencies are relatively inexpensive to administer and tabulate, and they provide good enough estimates of dietary intake to rank people by their food and nutrient intake levels. They tend to underestimate food intake and provide data that are more likely to fail to identify nutrient and health relationships than are quantitative assessment techniques such as the dietary history.[65-68]

Internet Dietary Assessment Resources Several high-quality Internet resources are available for dietary assessment.

USDA's Automated Multiple-Pass Method An interactive method for collecting 24-hour dietary recalls either in person, online, or by telephone has been validated by several studies.[67,68] It's the Automated Multiple-Pass Dietary Recall and is being used in government-sponsored nutrition studies such as the large "What We Eat in America" surveys. It utilizes a five-step, multiple-pass 24-hour recall. The term *multiple pass* refers to the repeated use of questions that hone the accuracy of information provided by interviewees about the food they ate the previous day.

The five-step interview process used by the automated multiple-pass method consists of the following:

1. **The Quick List** Quickly collect a list of foods and beverages consumed the previous day.
2. **The Forgotten Foods List** Probe for foods forgotten during development of the Quick List.
3. **Time and Occasion List** Collect information on the time and eating occasion for each food.
4. **The Detail Cycle** Collect detailed information on the description and amount of food consumed using the USDA's interactive Food Model Booklet and measuring guides.
5. **Final Probe Review** Review 24-hour recall and ask about anything else consumed.

An automated, self-administered 24-hour recall known the ASA24 is a freely available Web-based tool that enables automated self-administered 24-hour recalls and analysis.[69]

The Healthy Eating Index The HEI (Healthy Eating Index) assesses a person's reported dietary intake based on 10 dietary components that cover intake of the USDA's basic food groups informed by the Dietary Guidelines for Americans recommendations. The components are assigned scores based on the extent to which diets meet recommended standards of intake. The HEI is primarily used for population monitoring of dietary quality, evaluation of interventions, and research. It has been shown to be a valid tool for assessing dietary quality.[70]

	Frequency of Consumption								
Food	Never or less than once per month	1–3 per month	1 per week	2–4 per week	5–6 per week	1 per day	2–3 per day	4–5 per day	6+ per day
1. a. Broth-type soups, 1 cup									
b. Tap water, 1 cup									
c. Sparkling or mineral water, 1-cup serving									
d. Decaffeinated black tea, iced or hot, 1 cup									
e. Herbal tea, (no caffine) iced or hot, 1 cup									
2. Custard or pudding, 1/2 cup									
3. Onions, 1/4 cup, alone or in combination									

Figure 1.9 Example component of a food frequency questionnaire.
Source: J. Brown, University of Minnesota; Diana Project form, adapted from W. Willett's Food Frequency Questionnaire.

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Anthropometric Assessment

Individual measures of body size (e.g., height, weight, percent body fat, bone density, and head and waist circumferences) are useful in the assessment of nutritional status—if done correctly. Each measure requires use of standard techniques and calibrated instruments by trained personnel. Unfortunately, **anthropometric** measurements are frequently performed and recorded incorrectly in clinical practice. Training on anthropometric measures is often available through public health agencies and programs such as WIC (Special Supplemental Nutrition Program for Women, Infants, and Children), and courses and training sessions at colleges and universities.

Biochemical Assessment

Nutrient and enzyme levels, gene characteristics, and other biological markers are components of the biochemical assessment of nutritional status. Which nutrition biomarkers are measured depends on what problems are suspected, based on other evidence. For example, a young child who tires easily, has a short attention span, and does not appear to be consuming sufficient iron based on dietary assessment results may have blood taken for analyses of hemoglobin and serum ferritin (markers of iron status). Suspected inborn errors of metabolism that may underlie nutrient malabsorption may be identified through genetic or other tests. Such results provide specific information on a component of a person's nutritional status and are very helpful in the validation of dietary assessment results, and the diagnosis and treatment of particular conditions.

A number of references on normal levels of nutrition biomarkers in women and men are available.[71,72,73,74,75] Nutrient biomarker levels are reported in conventional units (such as ng/mL), or SI units (such as ng/mL). The second page of Appendix A shows you how to convert conventional units of measure to SI units, and visa versa. Nutritional biomarker values and reference ranges are affected by many variables, including sample and method of analysis used and population characteristics. They may change as more information becomes known about nutrient biomarker concentrations and health relationships. In the future, biochemical assessments will include a nutrigenomics profile to identify health risks due to interactions among an individual's genetic makeup, gene functions, and components of food.[72]

After the fact-finding phase of nutrition assessment, the dietitian nutritionist or other qualified professionals must apply their brains to their clients' problems. There is no one-size-fits-all approach to solving nutrition problems—each has to be figured out individually.

anthropometry The science of measuring the human body and its parts.

nutrition surveillance Continuous assessment of nutritional status for the purpose of detecting changes in trend or distribution in order to initiate corrective measures.

nutrition monitoring Assessment of dietary or nutrition status at intermittent times with the aim of detecting changes in the dietary or nutritional status of a population.

Table 1.18 U.S. national nutrition monitoring systems

Survey	Purpose
1. National Health and Nutrition Examination Survey (NHANES)	Assesses dietary intake, health, and nutritional status in a sample of adults and children in the United States on a continual basis
2. Nationwide Food Consumption Survey (NFCS)	Performs regular surveys of food and nutrient intake and understanding of diet and health relationships among national sample of individuals in the United States
3. Total Diet Study (sometimes called Market Basket Study)	Ongoing studies that determine the levels of various pesticide residues, contaminants, and nutrients in foods and diets

Monitoring the Nation's Nutritional Health

Food availability, dietary intake, weight status, and nutrition-related disease incidence are investigated regularly in the United States by the National Nutrition Monitoring System. This wide-ranging system is primarily responsible for the conduct of **nutrition surveillance** and **nutrition monitoring** studies.

The first U.S. nutrition survey began in 1936 when hunger, poor growth in children, and vitamin and mineral deficiencies were common. Today's surveys monitor rates of obesity, diabetes, and other nutrition-related disorders; the safety of the food supply (e.g., the mercury content of fish and pesticide residues in vegetables and fruits); and food and nutrient intake.

The major, ongoing U.S. studies related to diet, the food supply, and nutritional health are overviewed in Table 1.18. Together, with findings from studies conducted by university researchers and others, the results give direction to food and nutrition policies and programs aimed at safeguarding the food supply, improving the population's nutritional health, and maintaining a successful agricultural economy.[76]

1.5 Public Food and Nutrition Programs

A variety of federal, state, and local programs are available to provide food and nutrition services to families and individuals. Many communities have nutrition coalitions or partnership groups that collaborate on meeting the food and nutritional needs of community members. Programs representing church-based feeding sites, food shelves, Second Harvest Programs, the Salvation Army, missions, and others are usually a part of local coalitions. These central resources can be identified by contacting the local public health or cooperative extension agency. State-level programs are generally part of large national programs.

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More than one in three Americans participated in at least one of the USDA's 15 food assistance programs at some point during 2020.[77] The Supplemental Nutrition Assistance Program (SNAP) is the nation's largest food assistance program. The program also serves as a source of demand for the products of American farmers and food companies.[78] Some programs, such as the School Breakfast and Lunch Program, benefit many children. Other programs are targeted to families and individuals in need. *Need* is generally defined as including individual and household incomes below the poverty line. Some programs, such as WIC, have eligibility standards of up to 185 percent of the poverty line (Table 1.19). Income guidelines change periodically and are higher for people in Alaska and Hawaii.[79]

WIC

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) was established in 1972 and is administered by the USDA. The program provides nutrition education and counseling as well as food vouchers for low-income pregnant, postpartum, and breastfeeding women and for low-income children under the age of 5 years. Food vouchers apply to nutritious foods such as fortified breakfast cereals, iron-fortified infant cereals and formula, milk, cheese, eggs, peanut butter, dried beans, whole grain products, fruits, vegetables, and 100 percent fruit and vegetable juices. Some WIC programs offer vouchers for the purchase of produce at farmers' markets. WIC staff also provides breastfeeding support and referrals to health-care and social-service providers.

Eligibility for WIC is based on low-income status and the presence of a nutritional risk, such as iron deficiency or being underweight. WIC services are provided through approximately 10,000 clinic sites throughout the United States and in American Samoa, Guam, Puerto Rico, and the Virgin Islands. The program serves more than 7 million women and children each year. Nearly half of all infants and a quarter of all young children in the United States participate in the WIC program.[79,80]

Table 1.19 Income eligibility standards for the WIC program (185% of poverty income (July 1, 2022 to June 30, 2024)[79]

Household Size	Household Income Per Year
1	$25,142
2	$33,874
3	$42,606
4	$51,338
5	$60,070
6	$68,802
7	$77,534
8	$86,266
If you have more than 8 people in your household, call WIC	Each additional family member $8,732

The WIC program has been shown to have a number of positive effects on the health of participants. Infants born to parents participating in WIC while pregnant are less likely to be small at birth or to be born before term than the infants of nonparticipating low-income women. Children served by WIC tend to consume more nutritious diets and experience lower rates of iron deficiency than children who are low-income but not enrolled in WIC. WIC is cost effective: every dollar invested in WIC prenatal nutrition services saves $3.13 on Medicaid costs for infants during the first 2 years of life.[79]

Table 1.20 presents information on existing federal food and nutrition programs. You can get more information on these programs online at www.fns.usda.gov.

Nationwide Priorities for Improvements in Nutritional Health

Public health initiatives involving population-based improvements in food safety, food availability, and nutritional status have led to major gains in the health status of the country's population. Among the important components of this success story are programs that have expanded the availability of housing; safe food and water; foods fortified with iodine, iron, vitamin D, or folate; fluoridated public water; food assistance; and nutrition education. Today's priorities for improvements in the public's health and longevity center on reducing obesity, type 2 diabetes, and physical inactivity. Goals for dietary changes are a central part of the nation's overall plan for health improvements.[81]

Objectives related to the goals for improving the nutritional health of the nation are summarized in the document *Healthy People 2030* (Table 1.21). Because the seeds of many chronic diseases are planted during pregnancy and

Table 1.20 Examples of federal food and nutrition programs

Program	Activity
Child and Adult Care Food Program (CACFP)	Reimburses child and adult care organizations in low-income areas for provision of nutritious foods.
Summer Food Service Program	Provides foods to children in low-income areas during the summer.
School Breakfast and Lunch Programs	Provide free breakfasts and reduced-cost or no-cost lunches to children from families who cannot afford to buy them.
SNAP (Food Stamp Program)	Subsidizes food purchases of low-income families and individuals.
WIC	Serves low-income, pregnant, and breastfeeding women and children up to 5 years of age. Participants must have a nutritional risk factor to qualify. Provides supplemental nutritious foods and nutrition education as an adjunct to health care.
Head Start Program	Includes nutrition education for children and parents and supplies meals for children in the program. There are also state and local programs available.

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Table 1.21 Examples of the *Healthy People 2030* nutrition objectives for the nation

Health Conditions
• Reduce the burden of diabetes, and improve the quality of life for people who have or are at risk for diabetes. • Reduce the burden of chronic kidney disease and related complications. • Improve cardiovascular health and reduce deaths from heart disease and stroke. • Reduce overweight and obesity by helping people eat healthy and get physically active. • Prevent pregnancy complications and maternal deaths, and improve women's health before, during, and after pregnancy.
Health Behaviors
• Improve health by promoting healthy eating and making nutritious foods available. • Improve health, fitness, and quality of life through regular physical exercise. • Improve food handling practices. • Improve health, productivity, well-being, quality of life, and safety by helping people get enough sleep
Populations
• Improve the health and safety of infants. • Improve the health and well-being of children and adolescents. • Promote health and well-being for men and women. • Improve the health, safety, and well-being of lesbian, gay, bisexual, and transgender people. • Help parents and caregivers improve health and well-being for their loved ones and themselves.
Settings and Systems
• Promote healthier environments to improve health. • Improve health care. • Use health policy to prevent disease and improve health. • Make sure public health agencies at all levels have the necessary infrastructure for key public health services. • Promote health, safety, and learning in school settings.
Social Determinants of Health
• Increase social and community support. • Increase access to comprehensive, high-quality health-care services. • Increase educational opportunities, and help children and adolescents do well in school. • Create neighborhoods and environments that promote health and safety. • Help people earn steady incomes that allow them to meet

childhood, major emphasis is placed on diet and nutritional status early in life.[82,83]

1.6 Nutrition and Health Guidelines for Americans

In the United States and Canada, the national guidelines for diet and health are called the *Dietary Guidelines for Americans*, and the major educational tools for consumers based on the guidelines can be found at MyPlate.gov (Figure 1.10).

Dietary Guidelines for Americans

The *Dietary Guidelines for Americans* provide science-based recommendations to promote health and to reduce the risk for major chronic diseases through diet and physical activity. Due to its credibility and focus on health promotion and disease prevention for the public, the *Dietary Guidelines* form the basis of federal food and nutrition education programs and policies. Under legislative mandate, the *Dietary Guidelines for Americans* must be updated every 5 years.[84]

The *2025 Dietary Guidelines* highlight dietary patterns associated with decreased risk of obesity, heart disease, and diabetes; nutrient inadequacies; and physical activity.[80] The 2025 Dietary Guidelines Advisory Committee, which consisted of scientific experts on nutrition and health, concluded that the health of the U.S. population could be improved, and common chronic diseases and disorders prevented, if Americans consume a healthy dietary pattern (shown in Table 1.22) and exercise regularly. Key elements of the *2025 Dietary Guidelines* related to food and nutrient intake, dietary pattern, and food safety and sustainability are listed in Table 1.23.

Types and combinations of foods included in the Healthy Mediterranean-Style Dietary Pattern, the Healthy U.S.-Style Dietary Pattern, and the Healthy Vegetarian-Style Dietary Pattern are recommended by the guidelines.[80] Healthy dietary patterns are characterized by regular consumption of moderate portions of a variety of foods from each of the basic food groups.[85,86]

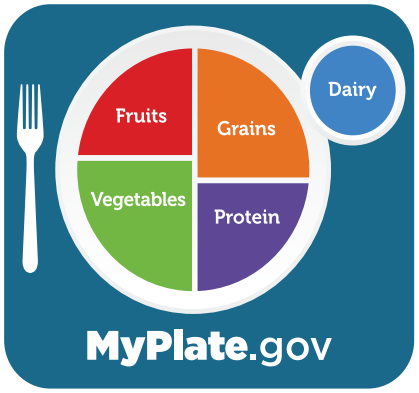
MyPlate.gov

MyPlate supports the healthy eating messages in the *Dietary Guidelines* through offering the following key pieces of advice:

- Make at least half your plate fruits and vegetables.
- Make half your grains whole grains.
- Eat fewer foods that are high in saturated fat, *trans* fats, added sugar, and sodium.
- Avoid oversized portions.
- Switch to fat-free or low-fat (1 percent) milk.



Courtesy of U.S. Department of Health and Human Services and U.S. Department of Agriculture



USDA

Figure 1.10 The major diet and health guides for Americans.

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Table 1.22 Characteristics of Healthy Dietary Patterns[13,52,83]

Healthy dietary patterns include the regular consumptions of: • Fruits and vegetables • Whole grains and whole grain products, and other high-fiber foods • Nuts, all types • Oils (such as olive oil, seed, and vegetable oils) • Legumes (such as navy and pinto beans) • Low-fat dairy products • Poultry, lean meats • Fish and seafood • Alcohol in moderation (by adults who chose to drink).
Healthy dietary patterns are *not* characterized by the regular consumptions of: • Foods and beverages high in added sugar such as sugar-sweetened soft drinks, fruit drinks, and sweetened teas • Foods high in sodium such as some fast- and processed foods • Refined grain products such as white bread, rice cakes, and pasta • Processed meats such as salami and bologna • Foods high in saturated fats, such as animal fat and tropical oils

- Drink water instead of sugary drinks.
- Compare sodium in foods like soup, bread, and frozen meals—and choose the foods with lower numbers.

The importance of consuming enough calories for growth and health while not consuming extra calories and gaining weight is also stressed. Regular physical activity (60 minutes per day for children and adolescents and 2½ hours or more per week of moderate activity for adults weekly) is stressed because it contributes to health maintenance and weight control. About half the U.S. population has diets that adhere to the dietary guidelines.

USDA's Food Groups

The USDA's long tradition of offering consumers a list of basic food groups is upheld in the current recommendations. Grains, vegetables, fruits, dairy, and protein foods are the designated groups. Examples of information available from MyPlate.gov are shown in Figure 1.11 and Table 1.24 and include:

- Sample menus based on a daily calorie need of 2,000.

Table 1.23 Key elements of the *2020–2025 Dietary Guidelines for Americans*[84]

1. Follow a healthy dietary pattern at every life stage—It is never to early or too late to eat healthy! • For the first 6 months of life Feed infants human milk exclusively and continue to feed infants human milk for the first year of life and beyond. If human milk is not available, feed infants iron-fortified infant formula. Provide infants vitamin D supplementation shortly after birth. • At about 6 months Provide infants with nutrient dense complementary foods. Encourage infants and toddlers to eat a variety of foods from all the food groups, and encourage consumption of foods rich in zinc and iron. Introduce infants to potentially allergenic foods. • From 12 months through older adulthood Follow a healthy diet across the lifespan to meet nutritional needs, maintain a healthy weight, and reduce the risk of disease.
2. Customize and enjoy nutrient-dense food and beverage choices to reflect personal preference, cultural traditions, and budgetary considerations. • Customize the guidelines to individual needs and preferences • Watch portion sizes
3. Focus on meeting food group needs with nutrient-dense foods and beverages. Stay within calorie limits. • Nutritional needs should be met mainly with foods and beverages. • A healthy diet should contain these core elements: • All types of vegetables • Fruit—especially who fruits • Grains—make at least half of these whole grains • Dairy—choose low-fat or fat-free options • Protein foods—Include a variety options: lean meats, eggs, poultry, seafood, lentils, beans, and peas. • Oils
4. Limit foods and beverages higher in added sugars, saturated fats, and sodium, and limit alcoholic beverages: • Added Sugars • For those under 2 years of age, avoid beverages and foods with added sugars • For those over 2 years of age, aim for less than 10% of total calories coming from added sugars. • Saturated Fats • Starting at 2 years of age, less than 10% of calories should come from saturated fats. • Sodium • For those 14 years and older aim for less than 2,300 mg of sodium. Those younger than 14 should consume less. • Alcoholic Beverages • Drinking less is healthier than drinking more. If you choose to drink, limit alcoholic beverages to 2 drinks or less per day for men and 1 drink or less per day for women. • Women who are pregnant should not drink alcohol.

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Sample Menus for a 2,000 Calorie Food Pattern

Day 1

Breakfast
Creamy oatmeal (cooked in milk):
- ½ cup uncooked oatmeal
- 1 cup fat-free milk
- 2 Tbsp raisins
- 2 tsp brown sugar

Beverage: 1 cup orange juice

Lunch
Taco salad:
- 2 ounces tortilla chips
- 2 ounces cooked ground turkey
- 2 tsp corn/canola oil (to cook turkey)
- ¼ cup kidney beans*
- ½ ounce low-fat cheddar cheese
- ½ cup chopped lettuce
- ½ cup avocado
- 1 tsp lime juice (on avocado)
- 2 Tbsp salsa

Beverage:
1 cup water, coffee, or tea**

Dinner
Spinach lasagna roll-ups:
- 1 cup lasagna noodles (2 oz dry)
- ½ cup cooked spinach
- ½ cup ricotta cheese
- 1 ounce part-skim mozzarella cheese
- ½ cup tomato sauce*

1 ounce whole wheat roll
- 1 tsp tub margarine

Beverage:1 cup fat-free milk

Snacks
2 Tbsp raisins
1 ounce unsalted almonds

Day 2

Breakfast
Breakfast burrito:
- 1 flour tortilla (8" diameter)
- 1 scrambled egg
- ⅓ cup black beans*
- 2 Tbsp salsa

½ large grapefruit
Beverage:
1 cup water, coffee, or tea**

Lunch
Roast beef sandwich:
- 1 small whole grain hoagie bun
- 2 ounces lean roast beef
- 1 slice part-skim mozzarella cheese
- 2 slices tomato
- ¼ cup mushrooms
- 1 tsp corn/canola oil (to cook mushrooms)
- 1 tsp mustard

Baked potato wedges:
- 1 cup potato wedges
- 1 tsp corn/canola oil (to cook potato)
- 1 Tbsp ketchup

Beverage:1 cup fat-free milk

Dinner
Baked salmon on beet greens:
- 4 ounce salmon filet
- 1 tsp olive oil
- 2 tsp lemon juice
- ⅓ cup cooked beet greens (sauteed in 2 tsp corn/canola oil)

Quinoa with almonds:
- ½ cup quinoa
- ½ ounce slivered almonds

Beverage:1 cup fat-free milk

Snacks
1 cup cantaloupe balls

Day 3

Breakfast
Cold cereal:
- 1 cup ready-to-eat oat cereal
- 1 medium banana
- ½ cup fat-free milk

1 slice whole wheat toast
- 1 tsp tub margarine

Beverage: 1 cup prune juice

Lunch
Tuna salad sandwich:
- 2 slices rye bread
- 2 ounces tuna
- 1 Tbsp mayonnaise
- 1 Tbsp chopped celery
- ½ cup shredded lettuce

1 medium peach
Beverage: 1 cup fat-free milk

Dinner
Roasted chicken:
- 3 ounces cooked chicken breast

1 large sweet potato, roasted
½ cup succotash (limas & corn)
- 1 tsp tub margarine

1 ounce whole wheat roll
- 1 tsp tub margarine

Beverage:
1 cup water, coffee, or tea**

Snacks
¼ cup dried apricots
1 cup flavored yogurt (chocolate)

Sample Menus for a 2,000 Calorie Food Pattern

Average amounts for weekly menu:

Food group	Daily average over 1 week
Grains	**6.2 oz eq**
Whole grains	3.8
Refined grains	2.4
Vegetables	**2.6 cups**
Vegetable subgroups (amount per week)	
Dark green	1.6 cups per week
Red/Orange	5.6
Starchy	5.1
Beans and Peas	1.6
Other Vegetables	4.1
Fruits	**2.1 cups**
Dairy	**3.1 cups**
Protein Foods	**5.7 oz eq**
Seafood	8.8 oz per week
Oils	**29 grams**
Calories From Added Fats and Sugars	245 calories

Nutrient	Daily average over 1 week
Calories	1975
Protein	96 g
Protein	19% kcal
Carbohydrate	275 g
Carbohydrate	56% kcal
Total fat	59 g
Total fat	27% kcal
Saturated fat	13.2 g
Saturated fat	6.0% kcal
Monounsaturated fat	25 g
Polyunsaturated fat	16 g
Linoleic Acid	13 g
Alpha-linolenic Acid	1.8 g
Cholesterol	201 mg
Total dietary fiber	30 g
Potassium	4701 mg
Sodium	1810 mg
Calcium	1436 mg
Magnesium	468 mg
Copper	2.0 mg
Iron	18 mg
Phosphorus	1885 mg
Zinc	14 mg
Thiamin	1.6 mg
Riboflavin	2.5 mg
Niacin Equivalents	24 mg
Vitamin B6	2.4 mg
Vitamin B12	12.3 mcg
Vitamin C	146 mg
Vitamin E	11.8 mg (AT)
Vitamin D	9.1 mcg
Vitamin A	1090 mcg (RAE)
Dietary Folate Equivalents	530 mcg
Choline	386 mg

Figure 1.11 ChooseMyPlate.gov sample menus and food group and nutrient analysis report for a 2,000-calorie food pattern.

Sources: Data from https://www.myplate.gov; and Daily Living Toolkit. Available at wordpress.com.

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Table 1.24 How much food counts as a cup or an ounce?

Vegetables:	1 cup = 1 cup raw or cooked vegetables or vegetable juice or 2 cups leafy salad greens
Fruits:	1 cup = 1 cup raw or cooked fruit or 100% fruit juice, or ½ cup dried fruit
Dairy:	1 cup = 1 cup milk, yogurt, or fortified soy milk; or 1½ ounces natural or 2 ounces processed cheese
Grains:	1 oz = 1 slice of bread, ½ cup cooked rice, cereal, or pasta; or 1 oz ready-to-eat cereal
Protein:	1 oz = 1 oz lean meat, poultry, or fish; 1 egg, 1 Tbsp peanut butter, ½ oz nuts or seeds; ¼ cup cooked dried beans or peas

- A listing of the number of servings of each basic food group that matches different levels of daily calorie need.
- Information on the amount of food in each basic food group that counts as a serving.

The DASH Diet This is a well-established healthy dietary pattern that has been described in detail. The pattern served as the basis for the development of the Healthy U.S.-Style Dietary Pattern. Originally published as a diet that helps control mild and moderate high blood pressure in experimental studies, the DASH Diet also reduces the risk of some types of cancer, osteoporosis, and heart disease. Improvements in blood pressure are generally seen within 2 weeks of starting this dietary pattern.[87,88]

The DASH dietary pattern emphasizes fruits, vegetables, low-fat dairy foods, whole-grain products, poultry, fish, and nuts. Only low amounts of animal fat, red meats, sweets, and sugar-containing beverages are included. This dietary pattern provides ample amounts of potassium, magnesium, calcium, fiber, and protein and limited amounts of saturated and *trans* fats. Recommendations for types and amounts of food included in this eating plan for a 2,000-calorie diet are shown in Table 1.25.

Table 1.25 A DASH eating plan for a 2,000-calorie diet

Food Group	Daily Servings (except as noted)	Serving Sizes
Grains and grain products	7–8	1 slice bread 1 cup ready-to-eat cereal* cup cooked rice, pasta, or cereal
Vegetables	4–5	1 cup raw leafy vegetable cup cooked vegetable 6 ounces vegetable juice
Fruits	4–5	1 medium fruit cup dried fruit cup fresh, frozen, or canned fruit 6 oz fruit juice
Low-fat or fat-free dairy foods	2–3	8 oz milk 1 cup yogurt 1 ounce cheese
Lean meats, poultry, and fish	2 or less	3 oz cooked lean meats, skinless poultry, or fish
Nuts, seeds, and dry beans	4–5 per week	⅓ cup or 1 oz nuts 1 Tbsp or 1 oz seeds ½ cup cooked dry beans
Fats and oils**	2–3	1 tsp soft margarine 1 Tbsp low-fat mayonnaise 2 Tbsp light salad dressing 1 tsp vegetable oil
Sweets	5 per week	1 Tbsp sugar 1 Tbsp jelly or jam ounce jelly beans 8 oz lemonade

*Serving sizes vary. Check the product's nutrition label.

**Fat content changes serving counts for fats and oils: For example, 1 Tbsp of regular salad dressing equals 1 serving; 1 Tbsp of a low-fat dressing equals 1 serving; 1 Tbsp of a fat-free dressing equals 0 servings.

Source: Dietary Guidelines for Americans, Appendix A-1: The DASH Eating Plan at 1,600-, 2,000-, 2,600-, and 3,100-Caloric Levels. Available at www.health.gov /dietaryguidelines /dga2005/document/pdf/Appendix_A.pdf.

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Review Questions

1. Nutrition is defined as "the study of foods, their nutrients and other chemical constituents, and the effects that food constituents have on health."

   _____ True _____ False

2. The word *nonessential,* as in *nonessential nutrient,* means that the nutrient is *not* required for growth and health.

   _____ True _____ False

3. Nutrients are classified into five basic groups: carbohydrates, protein, fats, vitamins, and water.

   _____ True _____ False

4. Tissue stores of nutrients decline after blood levels of the nutrients decline.

   _____ True _____ False

5. An individual's genetic traits play a role in how nutrient intake affects disease risk.

   _____ True _____ False

6. Groups of people at higher risk than others of becoming inadequately nourished include _____ and _____.

7. Almost all multiple-ingredient foods must be labeled with nutrition information.

   _____ True _____ False

8. In general, % DV of 10 percent or more listed for nutrients in Nutrition Facts panels are considered "low," and those listed as 50 percent or more are considered "high."

   _____ True _____ False

9. An overriding principle of nutrition labeling regulations is that nutrient content and health claims made about a food on the packaging must be truthful.

   _____ True _____ False

10. The term *enriched* on a food label means that extra vitamins and minerals have been added to the food to bolster its nutritional value.

    _____ True _____ False

11. You see a yogurt product at the grocery store labeled "fat free." This nutrient content claim means that a standard serving of the yogurt contains:
    a. No fat, or negligible amounts of fat
    b. No, or negligible amounts of, fat, *trans* fat, and sodium
    c. Fewer than 10 g of fat and 4.5 g of saturated fat
    d. Three grams of fat or less

12. Healthy individuals require the same nutrients throughout life, but the amounts of nutrients needed vary based on age, growth, and development.

    _____ True _____ False

13. Iron deficiency during childhood may decrease a child's ability to learn early in life but does not have a lasting affect on intellectual capacity.

    _____ True _____ False

14. The primary components of individual-level nutrition assessment consist of visual physical assessment, food frequency questionnaire administration, body weight measurement, and a blood draw.

    _____ True _____ False

15. Semiquantitative measures of dietary assessment provide good enough estimates of dietary intake to rank individuals by their food and nutrient intakes. Quantitative dietary assessment methods are needed to evaluate an individual's dietary intake.

    _____ True _____ False

16. The Supplemental Nutrition Assistance Program (SNAP), formerly called the Food Stamp Program, subsidizes food purchases of low-income families.

    _____ True _____ False

17. Individuals participating in the WIC program have one or more nutritional risk factors.

    _____ True _____ False

Questions 18–20 refer to the following scenario:

You are attending a family picnic and are staring at a variety of foods on a table that include fried chicken, cold-cut platter (bologna, salami), whole grain rolls, shrimp, Jell-o, spinach salad, fruit salad, baked beans, potato chips, zucchini squash, cake, and low-fat milk.

18. _____ From the food options available, which three foods would you put on your plate if you wanted to consume from the basic food groups?
    a. fried chicken, fruit salad, and baked beans
    b. zucchini squash, Jell-o, and baked beans
    c. spinach salad, cold cuts, and shrimp
    d. spinach salad, zucchini squash, and shrimp

19. Which of the following sets of foods would *not* be considered from the basic food groups?
    a. potato chips and cold cuts
    b. cake and spinach salad
    c. Jell-o and fruit salad
    d. fried chicken and zucchini squash

20. You decide to have a glass of milk along with shrimp, fruit salad, baked beans, and spinach salad. Which basic food group is missing from your plate?
    a. vegetables
    b. fruits
    c. grains
    d. protein foods

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Preconception Nutrition

Prepared by Judith E. Brown with Ellen Lechtenberg

Learning Objectives

After studying the materials in this chapter, you should be able to:

2.1 Cite three examples of the *Healthy People 2030* nutrition-related objectives for the preconception period.

2.2 Identify six major hormones involved in the regulation of male and female fertility processes, and identify their source and effects on the regulation of fertility processes.

2.3 Describe the potential effects of nutrition-related factors such as body fat content, iron status, and alcohol intake on fertility in women and men.

2.4 Cite four examples of relationships between nutrient intake and nutritional status during the periconceptional period and the outcome of pregnancy.

2.5 Develop a one-day menu for preconceptional individuals based on the MyPlate.gov food guidance materials.

2.6 Identify three nutrition-related consequences that may be related to the use of combination hormonal contraceptives, and a consequence that is related to the use of estrogen or progestin contraceptives only.

2.7 Cite three important nutrition-related components of preconceptional health care.

2.8 Describe the four steps of the Nutrition Care Process.

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Introduction

Human reproduction is the result of a superb orchestration of complex and interrelated genetic, biological, environmental, and behavioral processes.[1,2] In healthy individuals, these processes occur smoothly, and set the stage for successful reproduction. However, in less than healthy individuals, brought about by conditions such as acute undernutrition or high levels of alcohol intake, for example, can disrupt these finely tuned processes and diminish reproductive capacity. Sometimes conception occurs in the presence of poor nutritional or health status. Such events increase the likelihood that fetal growth and development, the health of the individual during pregnancy, and the future health of the offspring will be compromised.[3,4,5]

This chapter first highlights vital statistics related to the preconception period and presents background information on reproductive physiology. Then the focus turns to the effects of nutrition on fertility, the importance of nutritional factors during the periconceptional period, preconceptional nutritional status and the course and outcome of pregnancy, dietary recommendations for preconception, nutritional effects of contraceptives, and model programs that promote preconceptional nutritional health. The chapter ends with an overview and case study related to the Nutrition Care Process, an emerging system for the delivery of nutrition services to individuals before pregnancy and to others. The following chapter addresses the role of nutrition in specific conditions—such as premenstrual syndrome, diabetes, eating disorders, obesity, celiac disease, and polycystic ovary syndrome—that affect preconceptional health and fertility.

infertility Involuntary absence of production of children.

infecundity Biological inability to bear children after one year of unprotected intercourse.

fertility Actual production of children. The word best applies to specific vital statistic rates, but it is commonly taken to mean the ability to bear children.

fecundity Biological ability to bear children.

miscarriage Generally defined as the loss of a conceptus in the first 20 weeks of pregnancy. Also called spontaneous abortion.

fetus The developing organism from eight weeks after conception to the moment of birth.

endocrine A system of ductless glands, such as the thyroid, adrenal glands, ovaries, and testes, that produces secretions that affect body functions.

immunological Having to do with the immune system and its functions in protecting the body from bacterial, viral, fungal, or other infections and from foreign proteins (i.e., those proteins that differ from proteins normally found in the body).

subfertility Reduced level of fertility characterized by unusually long time to conception (over 12 months) or repeated pregnancy losses.

2.1 Preconception Overview

About 15 percent of all couples fail to conceive within 12 months of attempting pregnancy.[6] They are generally considered to be **infertile**, or more correctly **infecund**. **Fertility** refers to the actual production of children, whereas **fecundity** addresses the biological capacity to bear children. The actual production of children within population groups is assessed as the fertility rate, or the number of births per 1,000 women of childbearing age (15 to 44 years in most statistical reports). For example, in 2020, the fertility rate in the United States was 55.8 births per 1,000 women aged 15 to 44 years.[7] Even scientists and clinicians rarely use these terms correctly, however, so to avoid confusion, the familiar meanings of *fertility* and *infertility* are used in this chapter.

Infertility is generally defined as the lack of conception after one year of unprotected intercourse. This definition leads to a "yes/no" answer about fertility that is misleading. Approximately 44 percent of couples qualifying as infertile will eventually conceive a child without the help of fertility treatments.[8] Chances of conception decrease the longer infertility lasts as individuals age beyond 35 years.[9]

Healthy couples having regular, unprotected intercourse have a 30 percent chance of a diagnosed pregnancy within a given menstrual cycle.[10,11] However, many more conceptions probably occur. Studies show that 30 to 50 percent of conceptions are lost by resorption into the uterine wall within the first 6 weeks after conception. Another 9–10 percent are lost by **miscarriage** in the first 20 weeks of pregnancy.[12] The most common known cause of miscarriage is the presence of a severe defect in the **fetus**. Miscarriages can also be caused by maternal infection, structural abnormalities of the uterus, **endocrine** or **immunological** disturbances, and unknown, random events.[13]

Women who experience multiple miscarriages (variously defined as two or three), men who have sperm abnormalities (such as low sperm count or density, malformed sperm, or immobile sperm), and women who ovulate infrequently are considered **subfertile.** It is estimated that 18 percent of married, heterosexual couples in the United States are subfertile due to delayed time to conception (over 12 months) or repeated pregnancy losses.[14] A silver lining to subfertility is that the reproductive capacity of one individual can compensate for diminished potential in the other. In addition, subfertility can be diminished by improvements in diet, weight status, and lifestyle.[8]

2030 Nutrition Objectives for the Nation Related to Preconception

National priorities for improvement in health status during the preconception period include those related to nutrition (Table 2.1). The objectives represent priority problem areas

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Table 2.1 *Healthy People 2030* nutrition-related objectives for the nation for pregnancy and childbirth

• Reduce the rate of fetal deaths at 20 or more weeks of gestation.
• Increase the proportion of women who get screened for postpartum depression.
• Reduce the proportion of pregnancies conceived within 18 months of previous birth.
• Reduce pregnancies in adolescents.
• Increase the proportion of women and adolescents at risk for unintended pregnancy who use effective birth control.
• Reduce congenital syphilis.
• Reduce the rate of mother to child HIV transmission.
• Increase the proportion of pregnant women who receive early and adequate prenatal care.
• Reduce preterm deaths.
• Increase the proportion of women who had a healthy weight before pregnancy.
• Increase abstinence from cigarette smoking among pregnant women.
• Increase successful quit attempts in pregnant women who smoke.
• Increase the portions of women who get the Tdap vaccine during pregnancy.
• Reduce cesarean births among low-risk women with no prior births.
• Reduce maternal deaths.
• Reduce severe maternal complications identified during delivery hospitalizations.
• Increase abstinence from alcohol and illicit and opioids drugs among pregnant women.
• Reduce the proportion of unintended pregnancies.
• Increase the proportion of childbearing age who get enough folic acid.

Source: Healthy People 2030. Available at https://health.gov/healthypeople/objectives-and-data/brouse-objectives/pregnancy-and-childbirth, accessed April 7, 2023.

that focus policy development and program and service initiatives at the local, state, and national levels. Progress in meeting the health objectives for the nation is monitored on a regular basis.

2.2 Reproductive Physiology

The reproductive systems of female sex assigned at birth and male sex assigned at birth (Figure 2.1) begin developing in the first months after conception and continue to grow in size and complexity of function through **puberty.** Females are born with a complement of immature **ova** and male with sperm-producing capabilities. The capacity for reproduction is established during puberty when hormonal changes cause the maturation of the reproductive system over the course of 3 to 5 years.

Approximately 7 million immature ova, or *primordial follicles*, are formed during early fetal development, but only about one-half million per ovary remain by the onset of puberty. During a woman's fertile years, some 400–500 ova may mature and be released for possible fertilization. Due to losses in viable ova over time, very few remain by **menopause.** For men, sperm numbers and viability decrease somewhat after approximately 35 years of age, but sperm are produced from puberty until death. The quality of eggs and sperm decreases somewhat as an individual ages since damage to these cells' DNA accumulates.[10] Recent advances in knowledge may, in the future, extend the egg-producing life span of women through transplantation of egg producing stem cells into the ovaries.[11]

Female Reproductive System

During puberty, women develop monthly **menstrual cycles,** the purpose of which is to prepare an ovum for fertilization by sperm and the uterus for implantation of a fertilized egg. Menstrual cycles result from complex interactions among hormones secreted by the **hypothalamus**, the **pituitary gland,** and the ovary. This section focuses on the nutritional effects on hormonal changes in the menstrual cycle and on fertility.

Menstrual cycles tend to be 26 to 29 days long, but it is not uncommon for cycles to be several days shorter or longer. About 12 percent of cycles are the commonly self-reported 28 days long. The length of cycles vary from cycle to cycle and with increasing age.[11] The first day of the cycle is when menses, or blood flow, begins. The first half of the cycle is called the *follicular phase;* the last 14 days is the *luteal phase* (Figure 2.2).

Hormonal Effects During the Menstrual Cycle At the beginning of the follicular phase, estrogen stimulates the hypothalamus to secrete *gonadotropin-releasing*

puberty The period in life during which humans become biologically capable of reproduction.

ova Eggs of the female produced and stored within the ovaries (singular is *ovum*).

menopause Cessation of the menstrual cycle and reproductive capacity in women.

menstrual cycle An approximately 4-week interval in which hormones direct a buildup of blood and nutrient stores within the wall of the uterus and ovum maturation and release. If the ovum is fertilized by a sperm, the stored blood and nutrients are used to support the growth of the fertilized ovum. If fertilization does not occur, they are released from the uterine wall over a period of 3 to 7 days. The period of blood flow is called the *menses,* or the menstrual period.

hypothalamus A section of the brain responsible for the production of many hormones and other chemical substances that affect body functions such as temperature regulation, thirst, hunger, sleep, mood, reproduction, and the release of other hormones within the body.

pituitary gland A pea-sized gland located at the base of the brain. It is connected to the hypothalamus and produces and secretes growth hormone, prolactin, oxytocin, follicle-stimulating hormone, luteinizing hormone, and other hormones in response to signals from the hypothalamus.

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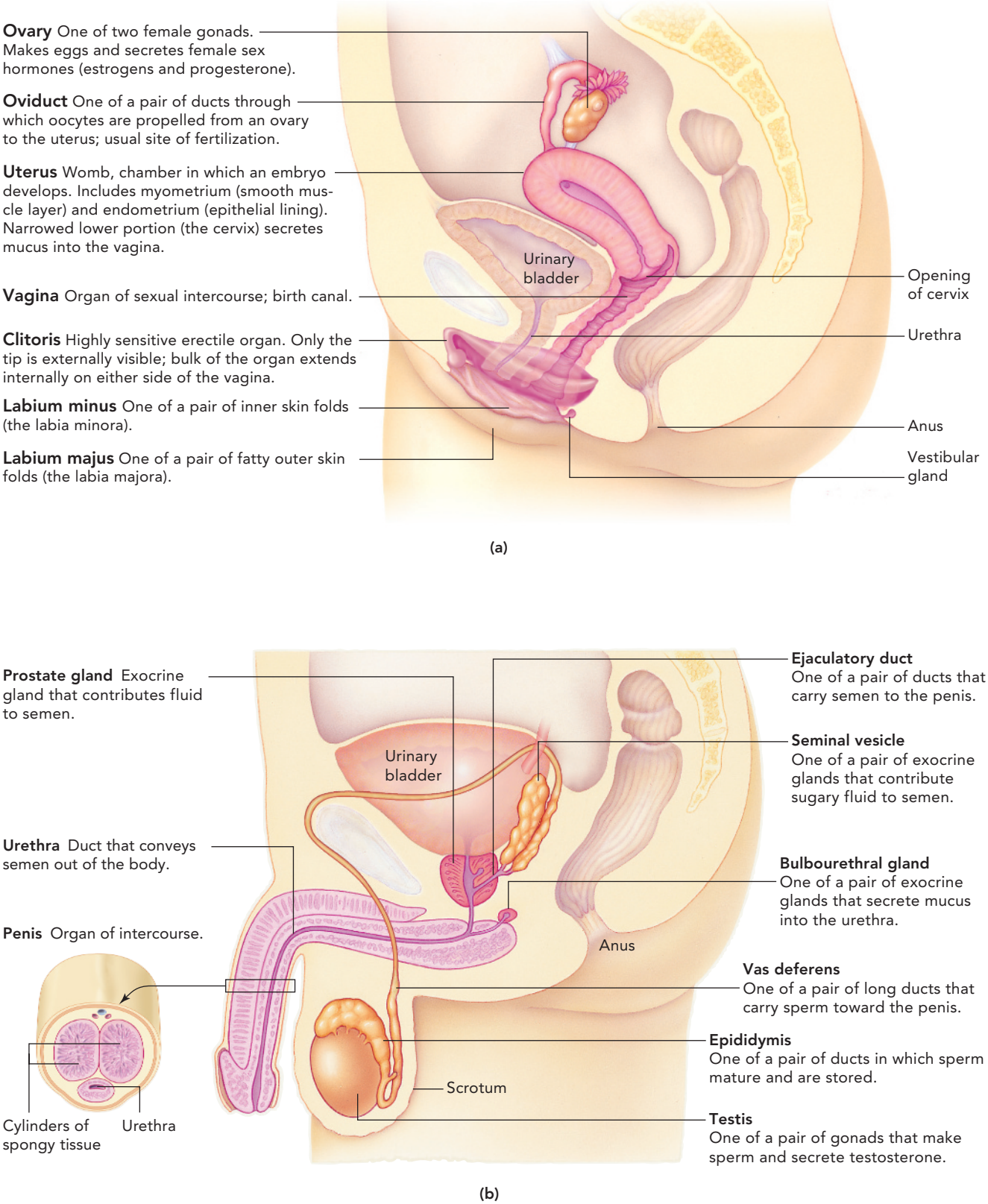


Figure 2.1 Mature (a) female and (b) male reproductive systems.

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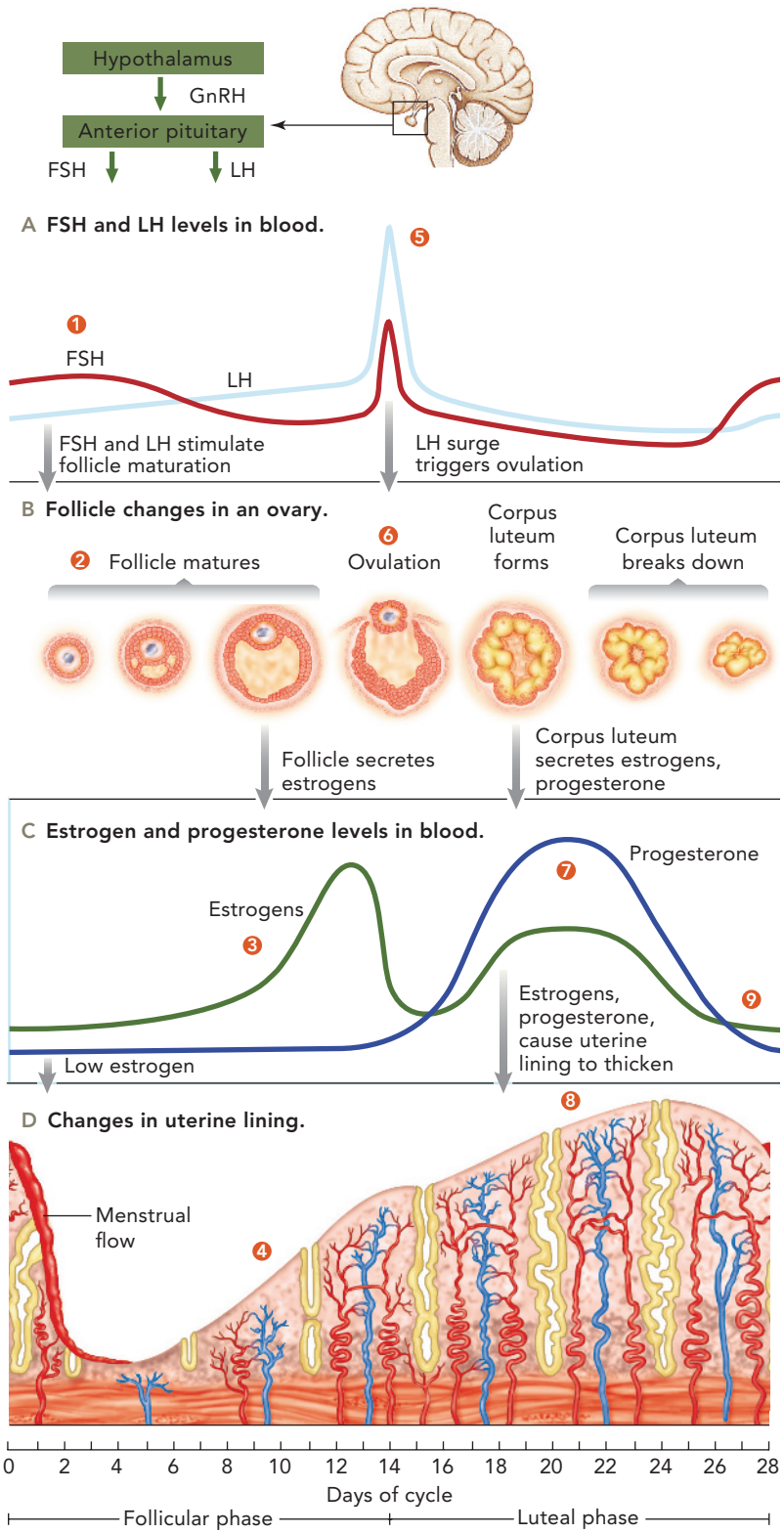


Figure 2.2 Changes in the ovary and uterus, correlated with changing hormone levels during the follicular and luteal phases of the menstrual cycle.

hormone (GnRH), which causes the pituitary gland to release the *follicle-stimulating hormone* (FSH) and *luteinizing hormone* (LH) (Table 2.2). FSH prompts the growth and maturation of 6 to 20 follicles, or capsules in the surface of the ovary in which ova mature. The presence of FSH stimulates the production of *estrogen* by cells within the follicles. Estrogen and FSH further stimulate the growth and maturation of follicles while rising LH levels cause cells within the follicles to secrete *progesterone*. Estrogen and progesterone also prompt the uterine wall (or endometrium) to store glycogen and other nutrients and to expand the growth of blood vessels and connective tissue. These changes prepare the uterus for nourishing a conceptus after implantation. Just prior to ovulation, which usually occurs on day 14 of a 28-day menstrual cycle, blood levels of FSH and LH peak. The surge in LH level results in the release of an ovum from a follicle, and voilà! Ovulation occurs.

The luteal phase of the menstrual cycle begins after ovulation. Much of the hormonal activity that regulates biological processes during this half of the cycle is initiated by the cells in the follicle left behind when the egg was released. These cells grow in number and size and form the **corpus luteum** from the original follicle. The corpus luteum secretes large amounts of progesterone and some estrogen. These hormones now inhibit the production of GnRH, and thus the secretion of FSH and LH. Without sufficient FSH and LH, ova within follicles do not mature and are not released. (This is also how estrogen and progesterone in some birth control pills inhibit ova maturation and release.) Estrogen and progesterone secreted by the corpus luteum further stimulate the development of the endometrium. If the ovum is not fertilized, the production of hormones by the corpus luteum declines, and blood levels of progesterone and estrogen fall. This decline removes the inhibitory effect of these hormones on GnRH release, and GnRH is again able to stimulate release of FSH for the

corpus luteum (*corpus* = body, *luteum* = yellow) A tissue about 12 mm in diameter formed from the follicle that contained the ovum prior to its release. It produces estrogen and progesterone. The "yellow body" derivation comes from the accumulation of lipid precursors of these hormones in the corpus luteum.

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Table 2.2 Hormones that regulate fertility processes

Hormone	Abbreviation	Source	Action
Gonadotropin-releasing hormone	GnRH	Hypothalamus	Stimulates release of FSH and LH
Follicle-stimulating hormone	FSH	Pituitary	Stimulates ovarian follicle growth and maturation, estrogen secretion, and endometrial changes characteristic of the first portion of the menstrual cycle in females. It stimulates sperm production in males.
Luteinizing hormone	LH	Pituitary	Stimulates ovulation, the development of the corpus luteum (which secretes progesterone), and the production of testosterone in males.
Estrogen (most abundant form is estradiol)		Ovaries, testes, fat cells, corpus luteum, and placenta (during pregnancy)	Stimulates release of GnRH in follicular phase and inhibits in luteal phase; stimulates thickening of uterine wall during menstrual cycle
Progesterone (progestin, progestogen, and gestagon are similar)		Ovaries and placenta	"Progestational," it prepares uterus for fertilized ovum and to maintain a pregnancy; stimulates uterine lining buildup during menstrual cycle; helps stimulate cell division of fertilized ova; inhibits action of testosterone
Testosterone		Mostly by the testes, ovaries	Stimulates maturation of male sex organs and sperm, formation of muscle tissue, and other functions

next cycle of follicle development, and of LH for the stimulation of progesterone and estrogen production. Decreased levels of progesterone and estrogen also cause blood vessels in the uterine wall to constrict, allowing the uterine wall to release its outer layer in the *menstrual flow*. Cramps and other side effects of menstruation can be traced to the production of **prostaglandins** by the uterus. These substances cause the uterus to contract and release the blood and nutrients stored in the uterine wall.

If the ovum is fertilized, it will generally implant in the lining of the uterus within 8 to 10 days. Hormones secreted by the dividing, fertilized egg signal the corpus luteum to increase in size and to continue to produce enough estrogen and progesterone to maintain the nutrient and blood vessel supply in the endometrium. The corpus luteum ceases to function within the first few months of pregnancy, when it is no longer needed for hormone production.

prostaglandins A group of physiologically active substances derived from the essential fatty acids. They are present in many tissues and perform such functions as the constriction or dilation of blood vessels and stimulation of smooth muscles and the uterus.

testes Male reproductive glands located in the scrotum. Also called testicles.

androgens Types of steroid hormones produced in the testes, ovaries, and adrenal cortex from cholesterol. Some androgens (testosterone, dihydrotestosterone) stimulate development and functioning of male sex organs.

Sertoli cells Cells in the testes that secrete substances that nourish and support the maturation of immature sperm cells.

epididymis Tissues on top of the testes that store sperm.

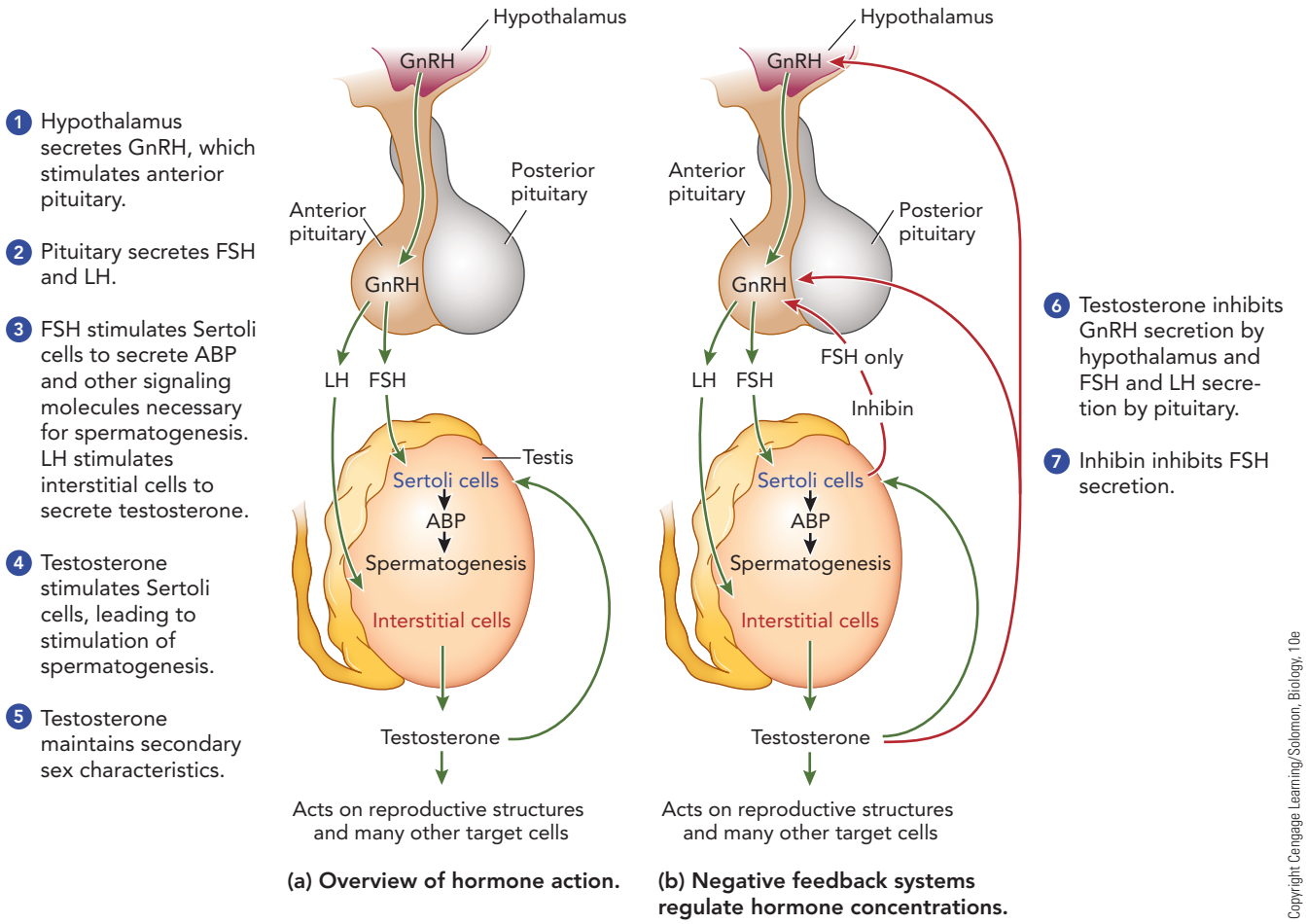
semen The penile ejaculate containing a mixture of sperm and secretions from the testes, prostate, and other glands. It is rich in zinc, fructose, and other nutrients. Also called seminal fluid.

Male Reproductive System

Reproductive capacity in men is established by complex interactions among the hypothalamus, pituitary gland, and **testes** (Figure 2.3). The process in men is ongoing rather than cyclic. Fluctuating levels of GnRH signal the release of FSH and LH, which trigger the production of testosterone (Table 2.2) by the testes. Testosterone and other **androgens** stimulate the production and maturation of sperm by way of **Sertoli cells**, which takes 70 to 80 days. When mature, sperm are transported to the **epididymis** for storage. Upon ejaculation, sperm mix with secretions from the testes, seminal vesicle, prostate, and bulbourethral gland to form **semen.** Just as some aspects of female reproductive processes remain unclear, scientists have yet to fully elucidate hormonal and other processes involved in male reproduction.

Sources of Disruptions in Fertility The intricate mechanisms that regulate fertility can be disrupted by many factors, including adverse nutritional exposures, severe stress, infection, tubal damage and other structural problems, and chromosomal abnormalities (Table 2.3).[3,6,15–19] Conditions that modify fertility appear to affect hormones that regulate ovulation, the presence or length of the luteal phase, sperm production, or the tubular passageways that ova and sperm must travel for conception to occur. Sexually transmitted infections (STIs), for example,

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Figure 2.3 Hormonal activity related to sperm production.

Table 2.3 Infertility risk factors for women and men[3,6,15–19]

Women and Men	Women	Men
• Weight loss 10 to 15% of normal weight • Inadequate antioxidant status (selenium, vitamins C and E) • Inadequate body fat • Excessive body fat, especially central fat • Extreme levels of exercise • High alcohol intake • Endocrine disorders (e.g., hypothyroidism, Cushing's disease) • Structural abnormalities of the reproductive tract • Chromosomal abnormalities in sperm and eggs • Celiac disease • Oxidative stress and chronic inflammation • Severe psychological stress • Infection (sexually transmitted diseases) • Diabetes, cancer, other disorders • Some medications • Smoking	• Recent oral contraceptive use (within two months) • Anorexia nervosa, bulimia nervosa • Vegan diets • Age 35 years • Metabolic syndrome • Pelvic inflammatory disease (PID) • Endometriosis • Polycystic ovary syndrome • Poor iron stores • High-fiber diet • History of miscarriage • History of pelvic surgery • Hormone imbalance • Contact with workplace toxins • Fallopian tube disease • Fibroids	• Inadequate zinc status • Heavy metal exposure (lead, mercury, cadmium, manganese) • Halogen (in some pesticides) and glycol (in antifreeze, de-icers) exposure • Estrogen exposure (in DDT, PCBs) • Sperm defects (quality, motility) • Excessive heat to testes • Steroid abuse • Mumps after puberty • Undescending testicles • Regular contact with radiation or welding • Exposure of genitals to high temperatures • Opioid-like medicines that effect the central nervous system • A genetic problem • A problem that was present at birth

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can result in **pelvic inflammatory disease (PID),** which may lead to scarring and blockage of the fallopian tubes.[20] **Endometriosis** is also a common cause of reduced fertility. It develops when portions of the endometrial wall that build up during menstrual cycles leave the uterus and become embedded within other body tissues.[21,22] Endocrine abnormalities that modify hormonal regulation of fertility are the leading diagnoses related to infertility. "Unknown cause" is the next most common diagnosis, applied to about 10 percent of all cases of male and female infertility.[15,23]

2.3 Nutrition and Fertility

In the past few decades, there has been an explosion in research reports related to the effects of nutrition and other lifestyle factors on fertility. Nutrition and lifestyles are now viewed as core components of the prevention and treatment of many cases of infertility.

Dietary pattern and nutrient intake from food and dietary supplements, calorie intake, and body fat affect fertility primarily by (1) altering the environment in which eggs and sperm develop, and (2) modifying levels of hormones involved in reproductive processes.[15,19,24] Nutrient intake and body fat before conception also influence a woman's health status during pregnancy and the growth and development of the fetus. Nutritional factors generally exert a temporary influence on fertility; normal fertility returns once the problem is corrected.

pelvic inflammatory disease (PID) A general term applied to infections of the cervix, uterus, fallopian tubes, or ovaries. Occurs predominantly in women who are less than 25 years of age and is generally caused by infection with a sexually transmitted disease, such as gonorrhea or Chlamydia.

endometriosis A disease characterized by the presence of endometrial tissue in abnormal locations, such as deep within the uterine wall, in the ovary, or in other sites within the body. The condition is quite painful and is associated with abnormal menstrual cycles and infertility in 30 to 40 percent of affected women.

leptin A protein secreted by fat cells that, by binding to specific receptor sites in the hypothalamus, decreases appetite, increases energy expenditure, and stimulates gonadotropin secretion. Leptin levels are elevated by high, and reduced by low, levels of body fat.

body mass index (BMI) Weight in kg/height in m^2. BMIs < 18.5 are considered underweight, 18.5–24.9 healthy weight, 25–29.9 overweight, and BMIs of 30 and higher obesity.

anovulatory cycles Menstrual cycles in which ovulation does not occur.

amenorrhea Absence of menstrual cycle.

Undernutrition and Fertility

Undernutrition among previously well-nourished women is associated with a dramatic decline in fertility that recovers when food intake does.[23,25] Food shortages in Europe in the 17th and 18th centuries were accompanied by dramatic declines in birth rates. Famine in Holland during World War II that led to calorie intakes of about 1,000 per day among women was associated with a 50 percent decline in fertility and a 53 percent decrease in birth rate. Fertility status improved within four months after the end of the famine, but for many women, it took as long as a year for their menstrual cycles to return to normal. Similarly, the 1974–1975 famine in Bangladesh resulted in a 40 percent decline in births.[26] More recent evidence indicates that relatively short periods of inadequate calorie intake or weight loss may temporarily decrease fertility in some women.[3,27]

Body Fat and Fertility

Excessive and inadequate levels of body fat are related to individual declines in fertility. Fat cells produce estrogen, testosterone, and **leptin,** and their availability changes with body fat content. Changes in the availability of these hormones interfere with reproductive processes such as follicular development, ovulation, and sperm maturation and production.

Excessive Body Fat and Fertility Obesity, or the existence of excessive body fat, is generally indicated by **body mass index** values over 30 kg/m^2. Most women and men who experience obesity are not infertile, but they are more likely to be subfertile than individuals within an ideal body weight range.[28,29] Women who are obese tend to have higher levels of estrogen, androgens, and leptin than women who are not obese.[28,29,30] These hormonal changes favor the development of menstrual-cycle irregularity (it occurs in 30 to 47 percent of women who are overweight and obese), ovulatory failure and **anovulatory cycles,** and **amenorrhea.**[15,29] Obesity in men is associated with lower levels of testosterone and increased estrogen and leptin levels.[31] These changes in hormonal status are related to reduced sperm production in 16 percent of men who are obese and experience higher-than-average rates of erectile dysfunction.[25] Loss of body fat is related to improvements in hormone levels, oxidative stress and chronic inflammation, and conception rates in individuals.[28,29]

Approximately 42 percent of adults in the United States experience obesity, making subfertility related to excess body fat a common problem and an important health and quality-of-life concern.[32] The multiple and complex effects of obesity on fertility and early pregnancy are addressed in more detail in Chapter 3.

Inadequate Body Fat and Fertility It appears that a critical level of body fat (usually indicated by a body mass index over 20 kg/m^2) is needed to trigger and sustain normal reproductive functions in women.[33,34,35] Low levels of body fat during adolescence is related to delays in the age of onset of menstruation and to reduced fertility later in life. Impaired

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fertility in women who are underweight often takes the form of delayed time to conception and amenorrhea. Lowered libido and reduced sperm production have been identified in men who are underweight with low levels of body fat.[33,36]

Weight Loss and Fertility in Individuals of Healthy Weights In women of healthy weights, weight loss that exceeds approximately 10 to 15 percent of usual weight decreases estrogen, LH, and FSH concentrations.[27,37] Consequences of these hormonal changes include amenorrhea, anovulatory cycles, and short or absent luteal phases. It is estimated that about 30 percent of cases of impaired fertility are related to simple weight loss. In the past, this form of amenorrhea was called *weight-related amenorrhea*. It is now called **functional hypothalamic amenorrhea**.[24] Hormone levels tend to return to normal when weight is restored to within 95 percent of previous weight. Case Study 2.1 provides an example of the effect of weight loss on fertility.

Weight gain is the recommended first-line treatment for amenorrhea related to low body weight, followed by health status, dietary intake, eating disorder, exercise intensity, and weight attitudes assessment.[24] In many cases, however, the advice to gain weight is more easily given than applied. About 10 percent of women who are underweight will not consider weight gain and may change health care providers in search of a different solution to infertility.[18]

Treatment of women who are underweight with Clomid (clomiphene citrate, a drug that induces ovulation) generally does not improve fertility until additional weight is gained.[27] Fertility may be improved through the use of GnRH, FSH, and other hormones. However, twice as many infants born to women who are underweight receiving such therapy are small for gestational age compared to infants born to women who are underweight who gain weight and experience unassisted conception.[25]

Weight loss decreases fertility in men just as it does in women. In the classic starvation experiments by Keys during World War II, men experiencing a 50 percent reduction in caloric intake reported substantially reduced sexual drive. Sperm viability and motility decreased as weight reached 10 to 15 percent below normal, and sperm production ceased entirely when weight loss exceeded 25 percent of normal weight. Sperm production and libido returned to normal after weight was regained.[36,37]

Nutrient Status and Fertility

A growing body of evidence indicates that healthy dietary patterns rich in plant foods that provide **antioxidants** as well as vitamins, minerals, and fiber influence health and fertility in women and men (Photo 2.1).[38,39] Antioxidant

functional hypothalamic amenorrhea (FHA) A non-organic (not due to disease) and reversible disorder in the hypothalamus that impairs gonadotropin-releasing hormone (GnRH) pulsatile secretion and suspends ovulation and menstrual cycles.

antioxidants Chemical substances that prevent or repair damage to molecules and cells caused by oxidizing agents. Vitamins C (see Photo 2.1) and E, selenium, and certain components of plants function as antioxidants.

Case Study 2.1 Cyclic Infertility with Weight Loss and Gain

After four years of experiencing amenorrhea, Tessa seeks medical care to help her become pregnant. She is convinced that her lack of menstrual periods is the cause of her infertility. Tessa's height is 5 ft 5 in.; her weight is 107 pounds, which she has maintained for four years (she previously weighed 121 pounds). Her FSH and LH levels are both abnormally low, and she is not ovulating. When the importance and methods of weight gain are explained to her, Tessa agrees to gain some weight. After she regains 7 pounds, her LH level is normal, but her FSH level is still low, and the luteal phase of her cycles is abnormally short. When her weight reaches 119 pounds, Tessa's LH and FSH levels, ovulation, and menstrual cycles are normal.

Questions

1. Was Tessa underweight or normal weight based on her body mass index (BMI, kg/m^2) when she weighed 107 pounds?
2. Can you determine Tessa's body fat content based on her BMI?
3. Why isn't Tessa ovulating?
4. What likely happened to Tessa's average estrogen level when her weight decreased from 121 to 107 pounds?
5. What are two likely reasons Tessa was advised to gain weight to improve her chances of conception rather than being given Clomid or another ovulation-inducing drug?



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Judith E. Brown

Photo 2.1 Apple slices exposed to air will turn brown due to oxidation reactions. The oxidation reactions are prevented if the slices are coated with a vitamin C–rich solution such as lemon juice.

nutrients are needed to protect cells of the reproductive system, including eggs and sperm, from damage due to oxidative stress. Oxidative stress occurs when the production of potentially destructive reactive oxygen molecules (**free radicals**) exceeds the body's own antioxidant defenses. Reactive oxygen molecules attack polyunsaturated fatty acids in sperm membranes, which decreases sperm motility and reduces the ability of sperm to fuse with an egg. Once the membrane surrounding sperm is damaged, reactive oxygen molecules can enter the sperm cell and damage DNA. This can result in the passage of defective DNA on to the conceptus.[38,40,41] Oxidative stress is observed in approximately half of men experiencing infertility.[42] In women, oxidative stress can harm egg and follicular development and can interfere with corpus luteum function and implantation of the egg in the uterine wall.[38]

free radicals Chemical substances (often oxygen-based) that are missing electrons. The absence of electrons makes the chemical substance reactive and prone to oxidizing nearby molecules by stealing electrons from them. Free radicals can damage lipids, cell membranes, DNA, and tissues by altering their chemical structure and functions. They also form as a normal part of metabolism. Over time, oxidative stress causes damage to lipids, cell membranes, DNA, cells, and tissues.

Antioxidant Status and Fertility A number of studies have shown lower intakes of antioxidant nutrients in individuals who experience infertility than individuals who are fertile. Other studies have noted that higher average intakes of antioxidants are associated with improvements in levels of oxidative stress in women experiencing infertility and improved sperm maturation, motility, concentration, and reduced DNA and chromosome damage in men.[40,41,43,44] A number of studies addressing the effects of antioxidant supplements on fertility have been undertaken but due to weaknesses in study designs no reliable conclusions about the effects can be stated.[17,23] It appears that dietary sources of antioxidants and correction of specific deficiencies with nutrient supplements may be beneficial.[40,45,46,47]

Zinc Status and Fertility in Men Zinc plays important roles in the reduction of oxidative stress, sperm maturation, and testosterone synthesis. It has been investigated for its potential role in infertility. Zinc deficiency in men has been found to be related to poorer sperm quality and sperm concentrations, and to abnormal sperm shapes.[48,49,50] Although it is clear that zinc deficiency can impair normal reproductive functions, it is not clear that supplemental zinc improves fertility in the absence of zinc deficiency.[44,46]

Iron Status and Fertility Poor iron status prior to pregnancy is a fairly common problem in women of childbearing age and is related to reduced fertility. Between 9 and 16 percent of women of childbearing age in the United States have iron deficiency and 14 percent have low iron stores.[51,52,53] Results of a large prospective study of nurses indicate that infertility due to a lack of ovulation is related to iron intake. In this study, women who regularly used iron supplements and consumed plant sources of iron were 60 percent less likely to develop ovulatory infertility than women who did not. Mechanisms underlying the link between iron status and ovulation are not yet established.[54]

Caffeine and Fertility Should adults attempting conception be concerned about coffee or caffeine intake? It is a reasonable question to ask because components of coffee, including caffeine, are biologically active and may potentially interact directly or indirectly with body processes involved with conception. But it is a difficult question to answer because a wide array of studies have examined this topic and results are mixed. It is not possible to conclude that coffee or caffeine intake is directly related to fecundity or the probability of conception, and there currently is no evidence-based recommendations related to coffee or caffeine intake during the preconceptional period.[55,56] Medical advice given to women or men to limit coffee or caffeine intake while attempting pregnancy is reasonably based on an abundance of caution.[56,57] Neither coffee nor caffeine are essential components of the diet and

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individuals who are concerned should not be dissuaded from cutting back or eliminating coffee or caffeine if they chose to do so (Table 2.4).

Alcohol and Fertility Approximately 12 percent of couples in the United States experience impaired fertility related to alcohol intake. Alcohol readily crosses the placenta to become a component of amniotic fluid and fetal tissues. Fetal development of the brain and other tissue and organs outcomes of these disruptions include birth defects, behavioral abnormalities, growth, and intellectual disabilities.

Table 2.4 Caffeine content of foods and beverages

Source	Caffeine (mg)
Coffee, 1 cup	
Drip	115–175
Decaffeinated (ground or instant)	0.5–4.0
Instant	61–70
Percolated	97–140
Espresso (2 oz)	100
Tea, 1 cup	
Black, brewed 5 minutes, U.S. brands	32–144
Black, brewed 5 minutes, imported brands	40–176
Green, brewed 5 minutes	25
Instant	40–80
Soft drinks	
Coca-Cola (12 oz)	47
Cherry Coke (12 oz)	47
Diet Coca-Cola (12 oz)	47
Dr. Pepper (12 oz)	40
Ginger ale (12 oz)	0
Mountain Dew (12 oz)	54
Pepsi-Cola (12 oz)	38
Diet Pepsi-Cola (12 oz)	37
7-Up (12 oz)	0
Energy drinks	
Rockstar Energy Shot (2.5 oz)	229
Five-Hour Energy (2 oz)	215
Full Throttle (8 oz)	210
Ripped Force (8 oz)	120
Monster Energy (8 oz)	92
Red Bull (8 oz)	80
Full Throttle (8 oz)	72
Jolt (12 oz)	72
Surge (8 oz)	35
Chocolate	
Cocoa, chocolate milk, 1 cup	10–17
Milk chocolate candy, 1 oz	1–15
Chocolate syrup, 1 oz (2 Tbsp)	4

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It is estimated that alcohol intakes in women of two drinks or more a day or more increases the risk of miscarriage and fetal death.[58]

It is generally recommended that individuals either not drink or limit alcohol intake to one drink a day for women, and two drinks a day for men if conception is possible. Once conception occurs, alcohol should not be consumed due to documented adverse effects of alcohol on fetal development.[59,60] Importantly, emphasis should be placed on healthy dietary patterns and lifestyles, including physical activity, along with considerations of the potential effects of alcohol intake on fertility.[58]

Heavy-Metal Exposure and Fertility Exposure to high levels of lead is related to decreased sperm production and abnormal sperm motility and shape.[61] Inhaled or ingested lead is transported to the pituitary gland, where it appears to disrupt hormonal communications with the testes. The result is lowered testosterone levels and decreased sperm production and motility. Men who are most likely to be exposed to excess lead tend to be workers in smelting and battery factories.[62,63]

Exposure to excess levels of cadmium, molybdenum, manganese, boron, cobalt, copper, nickel, silver, or tin may also affect male fertility.[63,64,65] These metals may build up in male reproductive systems through the inhalation of fumes or dust containing particles or through long-term use of dietary supplements, industrial pollution, or consumption of contaminated water.[66,67]

Physical Activity and Fertility The adverse effects of intense levels of physical activity on fertility were observed over 40 years ago in female competitive athletes. Since then, a number of studies have shown that female athletes may experience delayed age of puberty and lack menstrual cycles. Average age of menarche for competitive female athletes and ballet dancers is often delayed by 2–4 years.[68] The delay in menarche increases if women begin training for events that require thinness (such as gymnastics) before menarche normally would begin. Very high levels of exercise can also interrupt previously established, normal menstrual cycles. The presence of abnormal cycles reportedly ranges from about 23 percent in joggers to 86 percent in female bodybuilders (Table 2.5).[37,69]

Delays and interruptions in normal menstrual cycles appear to result from hormonal and metabolic changes primarily related to caloric deficits rather than intense exercise.[68,70] Metabolic and hormonal status generally reverts to normal after high levels of training and caloric deficits end. Some of the hormones involved in fertility impairments perform other important functions in the body, which may also be disrupted. Reduced levels of estrogen that accompany low levels of body fat and amenorrhea, for example, may decrease bone density and increase the risk of shortness, bone fractures, and osteoporosis.[67,70,71]

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Table 2.5 Estimates of the incidence of irregular or absent menstrual cycles in female athletes and sedentary women[37,69]

	Incidence of Irregular or Absent Menstrual Cycles
Joggers (5–30 miles per week)	23%
Runners (over 30 miles per week)	34%
Long-distance runners (over 70 miles per week)	43%
Competitive bodybuilders	86%
Noncompetitive bodybuilders	30%
Volleyball players	48%
Ballet dancers	44%
Sedentary women	13%

2.4 Nutrition During the Periconceptional Period

The time around conception is considered the **periconceptional period.** It represents a critical period of time when nutritional and other exposures can impact conception, pregnancy maintenance, and the growth, development, and future health of the offspring.[2] It has been variously defined as one month before conception through three months after conception in a study of the effects of alcohol intake on outcomes, to three months prior to pregnancy to one month postconception in an investigation of the effects of folic acid on outcomes.[72,73]

Most of the periconceptional period occurs before pregnancy is recognized or prenatal care has begun.[1] However, an extensive level of growth and development occurs within the early part of pregnancy. Approximately 8 to 10 days after an ovum is fertilized, it implants into the uterine wall. Within the first month after conception, the developing **embryo** will have grown from a single cell to millions of cells, basic structures of organs will have formed, and the blueprint for future growth and development will have been established.

Gene function in the embryo and fetus can be modified during early pregnancy by **DNA methylation.** Modifications in DNA functional status can affect growth, development, and disease risk later in life by a mechanism known as "metabolic programming."[74] Low-energy intakes during the periconceptional period due to food restriction, weight loss, eating disorders; or exposure to high amount of vitamin A in the form of retinol or retinoic acid from supplements or drugs used to treat acne for example, can modify gene functions in a developing embryo in ways that produce metabolic changes that influence the future health of the offspring (Table 2.6).[3,75,76] This chapter addresses the importance of adequate folate and iron intake during the periconceptional period, and Chapter 4 expands on the discussion of nutrition and fetal development.

periconceptional period The time period around conception, variously measured in weeks or months depending on the pregnancy outcomes of interest.

embryo The developing organism from conception through 8 weeks.

DNA methylation The modification of a replicated strand of DNA by addition of a methyl group (CH_3) to specific regions of the strand. Methylation can suppress the activity of certain genes in ways that affect metabolic processes and disease risk. It is a normal part of development and is needed for cellular differentiation and organ development but can also be influenced by nutritional and other environmental exposures.

neural tube defects (NTDs) A group of birth defects that are caused by incomplete development of the brain, spinal cord, or their protective coverings. Spina bifida is one of the most common types of neural tube defects.

Periconceptional Folate Status

Folate status prior to conception is an important concern because inadequate folate very early in pregnancy is related to the development of approximately 50 percent of cases of **neural tube defects (NTDs)**, such as spina bifida. NTDs develop between the third and fourth week after

Table 2.6 Periconceptional nutritional exposures that may disrupt fetal growth and development[32,59,60,98]

Weight Status
• Being underweight increases the risk of maternal complications during pregnancy and the delivery of small and early newborns. • Obesity increases the risk of clinical complications during pregnancy and delivery of newborns with neural tube defects or excessive body fat.
Nutrient Status
• Excessive vitamin A intake (retinol, retinoic acid) increases the risk the fetus will develop facial and heart abnormalities. • High maternal blood levels of lead increase the risk of intellectual disability in the offspring. • Iodine deficiency early in pregnancy increases the risk that children will experience impaired mental and physical development. • Iron deficiency increases the risk of early delivery and development of iron deficiency in the child within the first few years of life.
Alcohol
• Regular intake of alcohol increases the risk of *fetal alcohol syndrome* and *fetal alcohol effects*, both of which include impaired mental and physical development.
Diabetes
• Poorly controlled blood glucose levels early in pregnancy increase the risk of fetal malformations, excessive infant size at birth, and the development of diabetes in the offspring later in life.

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conception—or before many women even know they are pregnant, and well before prenatal care generally begins.[76] Folate is an essential nutrient required for DNA replication and as a component of enzymatic reactions involved in amino acid synthesis and vitamin metabolism.[77] Knowledge of the folate–neural tube defect relationship, and awareness that folate intake was inadequate in many women of childbearing age, prompted public health efforts to increase folate intake. In particular, efforts are focused on encouraging women to consume folic acid, a highly absorbable, synthetic form of this B vitamin. In 1998, that task was made easier when the Food and Drug Administration (FDA) mandated that refined grain products such as white bread, grits, crackers, rice, and pasta be fortified with folic acid. Many countries now fortify refined grain products with folic acid, and rates of NTDs have decreased significantly in these countries.[78] Rates of NTDs in countries that have not instituted folic acid fortification programs have not improved.[79,80]

There's another benefit related to improvements in folate status before conception: It lowers the risk of delivery of a baby that is **small for gestational age (SGA)**. Risk reduction does not appear to occur when inadequate folate status is improved after conception.[81,82]

Intakes of folic acid and folate status have increased substantially in most U.S. population groups since fortification. Average folate intake of women between the ages of 20 and 39 years in the United States is 527 DFE (**dietary folate equivalents**) per day, which is above the RDA of 400 DFE per day for folate for women in 20 to 39 years old.[83] Serum folate (a short-term indicator of folate status; and red-blood-cell folate concentrations (a marker of longer-term folate status) increased significantly after the institution of folic acid fortification and have remained fairly stable since 2006.[78]

The recommended intake of 400 mcg folic acid daily for preconceptional women can be obtained by consuming a serving of a breakfast cereal fortified with 400 mcg folic acid and other folic acid fortified refined grain products (Table 2.7).[84,85] Foods containing refined grains formulated to be gluten-free may not be fortified with folic acid.

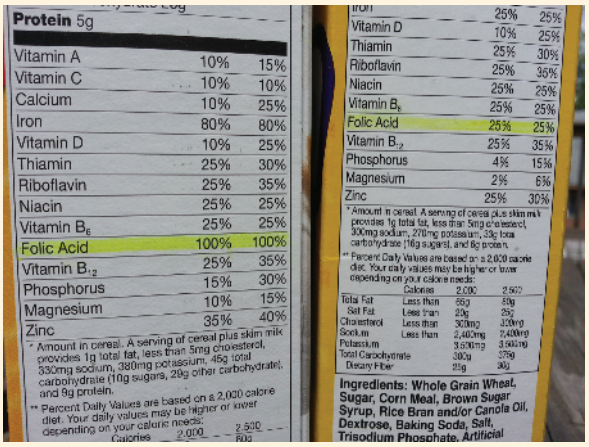
small for gestational age (SGA) Newborn weight is less than 10th percentile for gestational age. Also called small for date (SFD).

dietary folate equivalents (DFE) A measure of folate availability used by the Reference Dietary Intakes. 1 DFE = 1 mcg food folate, which is equivalent to 0.6 mcg folic acid.

Table 2.7 Examples of breakfast cereals that contain folic acid and other food sources of folic acid[a,84,85]

Fully Fortified Breakfast Cereals (400 mg Folic Acid Preserving)

Post Grape Nuts 47%
Post Honey Bunches of Oats with Almonds 100%
Post Honey Comb® 73.5%
Post Cocoa Pebbles® 85%
Kelloggs Fruit Loops® 20%
Kelloggs Special K® 98.5%
Kelloggs Frosted Mini Wheats® 100%
Kelloggs Frosted Flakes® 30%
General Mills Trix® 23.5%
General Mills Rice Checks® 51%
General Mills Total® >100%
Quaker Cap'n Crunch with Crunchberries >100%
General Mills Multi Grain Cheerios® 48.5%



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Folic Acid Content of Other Fortified Foods

Other Fortified Foods	Folic Acid Content (mcg)
Rice, white, cooked; 1 cup	104
Other breakfast cereals, 1 cup/1 oz	100
Pasta, cooked, 1 cup	92
Tortilla, flour, 1 large/2 oz	49
Bread, white, 1 slice/1 oz	46
Grits, cooked, 1 cup	36

[a]Product formulations may change. Confirm folic acid amount by checking the Nutrition Facts panel.

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Gene Variants and Folate Status

Some individuals have an increased need for folate due to specific gene variants involved in folate metabolism. These gene variants can impair the conversion of folate to its active form and increase folate requirement.[86] One of the best-studied and most common gene variants affects 5,10-methylenetetrahydrofolate reductase (MTHFR) activity. This enzyme is responsible for production of the major circulating form of folate used by the body. The C677T **allele** of the gene that encodes for MTHFR produces an enzyme that has reduced activity. Women with this **gene variant** are at increased risk of having an NTD-affected newborn.[87] Some population groups have higher incidence of the MTHFR gene variants associated with increased folate need and risk of NTD.[79]

Remaining Risk Group for Neural Tube Defects

Although the incidence of neural tube defects in the United States declined by 36 percent post-folic acid fortification, some women are still at risk. Risk groups for folate inadequacy and neural tube defects include Latinx women, particularly women from Mexico and Central America, women who take the anti-seizure drug valproate without appropriate folic acid supplementation, and women who have previously delivered an infant with a neural tube defect.[78,88,89] The increased risk of neural tube defects in Latinx women appears to be related to low intake of folic acid. Additionally, Latinx Americans as a group have a higher prevalence of a MTHFR gene variant that interferes with folate metabolism and increases folate need.[90] Low folic acid intakes have been related to the regular consumption of corn tortillas (Photo 2.2) and other foods made from corn flour not fortified with folic acid. In 2016, the FDA approved the voluntary addition of folic acid to corn flour products.[91,92]

In 1992, the Public Health Service issued a recommendation that women who have had a prior NTD-affected pregnancy take a 4.0 mg folic acid supplement before and early in pregnancy to help prevent recurrence. This recommendation was implemented prior to folic acid fortification and may be reconsidered. Current research indicates that 4.0 mg of folic acid per day is a suprathreshold dose related to high levels of folic acid excretion in urine. The high folic acid dose does not appear to improve folic acid functions beyond that achieved by intakes of 400 mcg per day before conception and during the first trimester of pregnancy.[76,93]

allele A different version of the same gene. Alleles have a different arrangement of bases than the usual version of the gene.

gene variant An alteration in the normal sequence of a gene. The different forms of the same genes are considered alleles.



Judith E. Brown

Photo 2.2 The nutrition information label on corn flour products will let you know if the product is fortified with folic acid.

Periconceptional Iron Status

Iron deficiency is the most common nutritional deficiency worldwide.[94] Iron deficiency prior to pregnancy increases the risk that iron-deficiency anemia will occur during pregnancy and that infants will be born with low stores of iron. Iron deficiency before pregnancy is also related to increased rates of preterm delivery.[95,96] It is easier and more efficient to build up iron stores before pregnancy than during pregnancy. Iron status has been found to improve by 15 weeks of pregnancy when women start increasing iron intake 2 to 3 months prior to conception. Women who start to increase iron intake a month after conception do not experience the same benefit.[97]

Iron status can generally be improved by the regular consumption of vitamin C–rich fruits and vegetables along with plant sources of iron, iron-fortified cereals, and lean meats, and by the use of modest doses of iron supplements (18 mg a day) if needed. Ideally, women would enter pregnancy with a sufficient level of stored iron to last throughout pregnancy.[98]

2.5 Recommended Dietary Intake and Healthy Dietary Patterns for Preconceptional Women

It is recommended that women who may become pregnant (1) consume 400 mcg of folic acid from fortified foods or supplements in addition to dietary folate from a variety of foods, (2) take no more than 10,000 IU of vitamin A (retinol or retinoic acid) from supplements daily, and (3) limit or omit alcohol-containing beverages. Recommendations for nutrient intake given in the Dietary Reference Intakes (DRIs)

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Table 2.8 MyPlate.gov 2,200-calorie plan for a 28-year-old woman and a 2,800-calorie plan for a 28-year-old man[a]

	Food Group						
	Calories	**Grains**	**Vegetables**	**Fruits**	**Dairy**	**Protein**	**Oils**
For a 28-year-old woman weighing 130 pounds, 5′6″ tall, and physically active 30–60 minutes per day:	2,200	7 oz	3 c	2 c	3 c	6 oz	6 tsp
For a 28-year-old man weighing 164 pounds, 5′10″ tall, and physically active 30–60 minutes per day:	2,800	10 oz	3.5 cup	2.5 cup	3 cup	7 oz	8 tsp

Advice:

- Make half your grains whole grains
- Vary your vegetables; include dark-green, red, and orange vegetables
- Drink fat-free or 1% milk
- Go lean with protein
- How much food counts as a cup or an ounce?

Vegetables:	1 cup = 1 cup raw or cooked vegetables or vegetable juice, or 2 cups leafy salad greens
Fruits:	1 cup = 1 cup raw or cooked fruit or 100% fruit juice, or ½ cup dried fruit
Dairy:	1 cup = 1 cup milk, yogurt, or fortified soy milk; or 1½ ounces natural or 2 oz processed cheese
Grains:	1 ounce = 1 slice of bread, ½ cup cooked rice, cereal, or pasta; or 1 oz ready-to-eat cereal
Protein:	1 oz = 1 oz lean meat, poultry, or fish; 1 egg, 1 Tbsp peanut butter, ½ oz nuts or seeds; ¼ cup cooked dried beans or peas

[a]Visit SuperTracker at MyPlate.gov to identify food group recommendations based on various levels of calorie need.

should be applied in making food and dietary supplement decisions while paying specific attention to the Tolerable Upper Intake Levels for nutrients.[99,100,101] For both women and men, energy and nutrients requirements should be met by foods rather than supplements if possible.[102]

Healthy dietary patterns are described by the 2020 Dietary Guidelines Advisory Committee as those that focus on basic, nutrient-dense foods including fish, poultry, lean meats, vegetables, fruits, legumes, whole grains and whole grain products, and oils. These healthy dietary patterns are associated with a reduced risk of poor pregnancy outcomes, improved infant and child health and development, and decreased risk of chronic health problems later in life.[74] Poor-quality diets highlighted by "empty calorie" foods such as sweet snack, desserts, and beverages, and salty snacks, beer, and pasta are more common in groups of individuals at high risk for poor pregnancy outcomes than individual consuming a healthy dietary pattern.[103] Dietary patterns prior to pregnancy generally continue during pregnancy, so it is helpful to enter pregnancy while consuming a healthy one.[104]

Food selection prior to pregnancy can be based on USDA's MyPlate.gov healthy dietary pattern guidance information (see Table 2.8). The types and number of servings recommended from each food group are determined primarily by a person's calorie and nutrient needs based on age, sex, height, weight, and physical activity level. A balanced diet high in nutrient-dense foods promotes general health and normal weight status, and helps prepare women for the nutrient needs of pregnancy (Table 2.9).[105]

Table 2.9 Example 2,000-calorie, 1-day menu from MyPlate.gov

Breakfast
1 whole wheat English muffin
1 Tbsp all-fruit preserves
1 hard-cooked egg
Beverage: 1 cup water, coffee, or tea
Lunch
White bean-vegetable soup:
1¼ cup chunky vegetable soup with pasta, ½ cup white beans
6 saltine crackers
½ cup celery sticks
Beverage: 1 cup fat-free milk
Dinner
Rigatoni with meat sauce:
1 cup rigatoni pasta (2 oz dry)
2 oz cooked ground beef (95% lean)
2 tsp corn/canola oil (to cook beef)
½ cup tomato sauce
3 Tbsp grated parmesan cheese
Spinach salad:
1 cup raw spinach leaves, ½ cup tangerine sections, ½ oz chopped walnuts, 4 tsp oil and vinegar dressing
Beverage: 1 cup water, coffee, or tea
Snack
1 cup nonfat fruit yogurt

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2.6 Influence of Contraceptives on Preconceptional Nutrition Status

Many types of contraceptives are available by prescription. These contraceptives contain forms of estrogen, mainly estradiol, and/or progestin (the term used for progesterone, the natural hormone), and progestogen (the synthetic form). Estradiol is always combined with progestin, but some contraceptives employ progestin only for women who, for health reasons, cannot take estrogen. When used together, estradiol and progestin suppress the action of LH and FSH and thereby ovulation. Progestin blocks LH and ovulation, and, by causing the cervical mucus to become thick and sticky, it induces a barrier to sperm. Hormonal contraceptives are available as pills, patches, implants, and injections. All are effective at preventing pregnancy if used correctly.[106]

Nutritional Side Effects of Hormonal Contraception

The estradiol and progestin content of contraceptives in the current third generation of contraceptives is lower than earlier generations of contraceptive[107] and the forms of the hormones used have become more targeted.[108] Their use is associated with far fewer side effects than the earlier versions, and complications related to their use are rare.[109] Combination hormonal contraceptives, such as most oral contraceptives, do not appear to be associated with weight gain.[110,111] Progestin-only hormonal contraceptives such as Depo-Provera are associated with weight gain. Women using progestin for contraception gain, on average, around 10 pounds within the first five years of use. The gain has been found to be related to increased fat storage rather than to fluid or lean tissues. Progestin-only contraceptives have been found to decrease bone mineral accretion in adolescents.[111,112]

Estradiol and progestin contraceptive use appears to be associated with altered blood lipid levels and glucose metabolism, as well as other changes in health status.[111] Combination contraceptives tend to decrease HDL cholesterol, increase LDL cholesterol and triglyceride concentrations, increase blood glucose and insulin levels, and increase inflammation somewhat.[108] Metabolic changes associated with estradiol appear to increase the risk of stroke due to blood clots and heart attack in some users.[113] Whether combined contraceptives increase the risk of type 2 diabetes is not yet clear.[114]

Hormonal contraceptives may not be recommended for women at risk of cardiovascular disease or blood clots, and women with high blood pressure. Women who use these contraceptives are advised not to smoke.[113,114] Fertility usually resumes within 3 to 6 months after contraceptive use stops, but some women regain it sooner.[106]

Effective and safe hormonal forms of contraception for men are being developed but are not yet approved for use. Despite the availability of numerous, effective and relatively safe contraception methods for women, no similar contraceptives are available to men aside from tubal ligation. Consequently, reliable control of conception primarily depends on female contraception use.[109,115]

2.7 Model Preconceptional Health and Nutrition Programs

Effects of three preconceptional nutrition programs on women's health before and during pregnancy and offspring outcomes are highlighted here. The first is the Special Supplemental Nutrition Program for Females, Infants, and Children (WIC), and the other two are programs that involved vitamin and/or mineral supplementation prior to pregnancy on pregnancy outcomes.

The WIC program serves to safeguard the health of low-income pregnant, postpartum, and breastfeeding women, infants, and children up to age 5 who are at nutritional risk by providing nutritious foods to supplement diets, information on healthy eating including breastfeeding promotion and support, and referrals to health care. It serves about 9 million pregnant and breastfeeding women, infants, and young children in the United States yearly.[116] Through services provided to postpartum women and nutrition education delivered during infancy and early childhood, WIC is in a position to benefit preconceptional women in the next pregnancy even through they are not a specific target audience for the program.[117]

Preconceptional Benefits of WIC

Potential benefits of WIC services to women during pregnancy, as well as between consecutive pregnancies, were assessed in a study in California. One group of women received WIC benefits during one pregnancy through the first two months of the next pregnancy. The control group received WIC services during pregnancy only. Women who received WIC services through to a subsequent pregnancy had better iron status and delivered newborns with higher birthweights and greater lengths than did women who received WIC benefits during pregnancy only.[118] The study indicates that low-income women at nutritional risk benefit from WIC services from one pregnancy to the next.

In 2012, the USDA launched a grants program in collaboration with the University of California at Los Angeles that is evaluating the impact of the existing WIC program on periconceptional nutrition. The intention of the research is to measure the cost and benefits of WIC services on outcomes such as ovulatory infertility, birth defects, complications during pregnancy, preterm birth,

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and low birthweight.[117] Depending on the results of these studies, preconceptional woman may become eligible for WIC services.

Decreasing Iron Deficiency in Preconceptional Women in Indonesia

Approximately one in every two women in Indonesia experiences iron-deficiency anemia during pregnancy. In a unique effort to prevent this problem, the Ministry of Health initiated regulations that require a couple applying for a marriage license to receive advice on iron status from those dispensing the license. All women are now advised to take 30 to 60 mg of iron along with folic acid in a supplement. Of 344 women studied after the program was initiated, 98 percent reported that they had purchased and taken iron folate tablets; 56 percent had taken at least 30 tablets. The incidence of iron deficiency in this group of women dropped by almost half.[119]

Preconceptional Vitamin and Mineral Supplementation in Vietnam Results of a large study of preconceptional women and their offspring indicate that iron and folic acid, or a multivitamin and mineral supplement taken prior to pregnancy may benefit pregnancy outcomes. Offspring of women given the supplements before conception were less likely to be stunted and had better fine motor skills at age 2 than a woman who received only folic acid supplements.[120] Results of this study add to a growing list of benefits of supplementation with needed nutrients before pregnancy.[121]

Preconception Care: Preparing for Pregnancy

Increasingly, routine preconceptional health-care visits and educational sessions are being recommended and introduced into health-care services. Risk assessment services focus on ascertainment of:

- Health history
- Dietary intake
- Folate and iron status
- Weight status
- Drug and alcohol use
- Dietary supplement use
- Vaccination status

Psychosocial needs should also be addressed as part of preconceptional care, and referrals made to appropriate services for issues such as eating disorders, abuse, violence, or lack of food or shelter.[122] The desire of couples planning for pregnancy to have a healthy newborn makes the preconceptional period a prime time for positive behavioral changes. It presents opportunities to make lasting improvements in the health and well-being of individuals and families.

CDC's Preconception Health Initiative Efforts to boost the availability and utilization of preconception care services by underserved and low-income individuals are bolstered by the Centers for Disease Control and Prevention (CDC). The CDC initiated activities in this area based on preconception health objectives established by the Health Objectives for the Nation report for the year 2020. The objectives focus on improving the persistent problem of higher rates of poor pregnancy outcomes in the United States compared to other developed nations, and the especially high rates of poor pregnancy outcomes in low-income populations. The CDC periodically updated reports on, and recommendations for, preconceptional health care services.[122]

In addition to risk assessment services, current CDC recommendations for preconceptional care include:

- Education about preconceptional health and pregnancy outcome
- Provision of needed vaccinations and other primary care services needed for management of disease and disorders such as diabetes, hypertension, and celiac disease
- Education on prevention of Coronavirus-19

Starting pregnancy in the best health status possible can make an important difference to reproductive outcomes. Even in ideal conditions, continued infertility, early pregnancy loss, fetal malformations, and maternal complications will sometimes occur.

2.8 The Nutrition Care Process

The Academy of Nutrition and Dietetics has developed nutrition care standards intended to serve as guidelines for the delivery of nutrition services.[123] The standards are called the Nutrition Care Process (NCP), and they are part of new technology-based systems being developed to facilitate health-services delivery and cost evaluation, electronic charting, coding, and outcome measurement. The process is being evaluated and will be revised and updated as needed on an ongoing basis.

The NCP focuses on the delivery of effective nutrition care through the use of:

- A common approach to, and standardized methods for, nutrition assessment.
- Specific terms to describe nutrition diagnoses identified by the nutrition assessment. Nutrition diagnoses are treated independently by a nutrition practitioner.

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- Effective intervention plans and goals related to treating the specific nutrition diagnoses.
- Nutrition monitoring and evaluation techniques that identify client/patient outcomes relevant to the nutrition diagnoses and the intervention plans and goals.[124]

The NCP in practice consists of four steps:

1. Nutrition assessment
2. Nutrition diagnosis
3. Nutrition intervention
4. Nutrition monitoring and evaluation

Table 2.10 summarizes components of these four steps.

The Nutrition Care Process Related to the Preconception Period

Components of the Nutrition Care Process vary to some extent based on the life-cycle stage of the individuals being served. Preconception services are tailored to the nutritional needs of women before pregnancy, and to the nutrition and reproductive health needs of men. Topics such as weight status; folic acid, iron, and antioxidant intake; dietary supplement use; reproductive history; contraceptive use; and effects of existing disorders on early fetal development would be addressed as part of the nutrition care process. Case Study 2.2 addresses a preconception health problem related to nutrition and asks students to use the Nutrition Care Process to formulate responses to questions asked about the case.

Table 2.10 Summary of the components of the four steps of the Nutrition Care Process[123,124]

Step 1: Nutrition Assessment
• Food/Nutrition-Related History   • Food and nutrient intake (e.g., diet history, fat intake)   • Medicinal/dietary supplement intake (e.g., medications, supplement use)   • Knowledge/beliefs/attitudes (e.g., level of nutrition knowledge, unscientific beliefs, attitudes)   • Nutrition-related behaviors (e.g., binge-eating behavior, willingness to try new foods)   • Food and supplies availability (e.g., eligibility for and utilization of government/community food and nutrition programs)   • Physical activity (e.g., physical activity history, intensity) • Biochemical Data, Medical Tests, and Procedures   • Tests (e.g., resting metabolic rate, bone density) • Anthropometric Measurements   • Body size, growth (BMI, growth pattern) • Client History   • Medical history, treatments, use of alternative/complementary medicine, social history
Step 2: Nutrition Diagnosis
• Identification of nutrition-specific problem(s) based on results of the nutrition assessment. Diagnoses are classified as being related to: • Food and nutrient intake (e.g., food and nutrient amounts consumed relative to need, such as “excessive energy intake,” “underweight,” and “excess fat intake”)   • Clinical (e.g., nutrition problems related to medical and physical conditions such as “swallowing difficulties due to [name the factor, e.g., lack of saliva],” “breastfeeding difficulty due to [name the factor, e.g., failure to obtain a let-down reflex],” and “altered lab value, low vitamin D due to [name the factor, e.g., sun sensitivity]”)   • Behavioral-environmental (e.g., problem related to behavior, knowledge, beliefs, and access to food such as “food and nutrition-related knowledge deficit” and “limited access to food”)
Step 3: Nutrition Intervention
• Identify and implement effective, individually tailored nutrition interventions that will resolve or improve the nutrition problems identified. Nutrition intervention strategies are organized into four categories: 1. Food and/or nutrient delivery   2. Nutrition education   3. Nutrition counseling   4. Coordination of nutrition care
Step 4: Nutrition Monitoring and Evaluation
• Measure and monitor changes in the client’s nutrition-related health status and evaluate the effectiveness of the intervention based on client nutrition and health outcomes.

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Nutrition Care Process (NCP) Case Study 2.2 Male Infertility

This case study requires the use of the Academy of Nutrition and Dietetics' Nutrition Care Process.

Michael, a 29-year-old man, and Darla, a healthy 32-year-old woman have been unable to conceive after 2 years of unprotected intercourse. Results of medical tests led Michael to be diagnosed with male-factor infertility due to low sperm production. No other health problems were identified. His weight was assessed to be 260 lbs (118 kg) and his height measured 5 ft 10 in. (1.78 m). Michael was referred to a registered dietitian for nutritional assessment, diagnoses, intervention, and follow-up.

Results of the nutritional assessment revealed that Michael was physically inactive and consumed an average of 145 calories more per day than recommended based on his weight, height, and physical activity level. Results of assessments of Michael's dietary and supplement intake; nutrition-focused physical findings; nutrition knowledge, behaviors, and beliefs; and food availability revealed no additional problem areas.

Questions

1. What is Michael's BMI?
2. Name an appropriate priority nutrition diagnosis for this case.
3. Name one potential nutrition intervention that addresses the nutrition diagnosis.
4. Cite one nutrition-related indicator that could be used to monitor and evaluate the intervention.



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Key Points

1. Preconceptional nutritional status influences maternal health and the course and outcome of pregnancy.
2. The *Healthy People 2030* nutrition objectives for preconception focus on improving weight status prior to pregnancy, decreasing alcohol consumption around the time of conception, deceasing inadequate iron and folate status, and expanding the utilization of preconceptional care services.
3. Dietary intake, supplement use, weight status, and body fat content affect the development and maintenance of a person's biological capacity to reproduce.
4. The major hormones involved in the regulation of fertility processes in women and men are gonadotropin-releasing hormone (GnRH), follicle-stimulating hormone (FSH), leutinizing hormone (LH), estrogen, progesterone, and testosterone. These hormones can be affected by nutritional status.
5. Inadequate and excessive levels of body fat, weight loss in normal-weight individuals, oxidative stress and chronic inflammation, low antioxidant intake from vegetables and fruits, high alcohol intake, eating disorders, certain chronic health problems, inadequate zinc status, and heavy-metal exposure are related to fertility.
6. The effects of hormonal contraceptives on body weight and on blood lipid, insulin, and glucose concentrations depend on the estradiol and progestin content of the contraceptive.
7. Adequate folate status prior to pregnancy substantially reduces the risk of neural-tube and other defects in newborns. Some cases of inadequate folate status are related to gene variants that increase the need for folate.
8. Low iron stores prior to pregnancy increase the risk of iron deficiency during pregnancy, preterm delivery, and low iron stores in the infant. Iron stores can be more effectively accumulated prior to rather than during pregnancy.
9. A healthy, preconceptional dietary pattern for women and men is described by the MyPlate.gov food guidance material.
10. The periconceptional period represents a critical period of time when nutritional and other exposures can impact conception, pregnancy maintenance, and the growth, development, and future health of the offspring.
11. Preconception health services should be a part of primary health care and would likely improve fertility and pregnancy outcomes.
12. The process by which nutrition care service should be provided to preconceptional individuals has been defined by the Academy of Nutrition and Dietetics.

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Review Questions

1. Which of the following is a nutrition objective for preconception included in *Healthy People 2030*?
   a. Decrease the proportion of men who consume soy products before conception.
   b. Increase the proportion of women of childbearing age who get enough folic acid.
   c. Increase the proportion of women and men who consume less than 30 percent of total calories as fat prior to pregnancy.
   d. Increase the proportion of men and women who regularly take a multivitamin and mineral supplement prior to pregnancy.
2. Nutrient intake from food, calorie intake, and body fat affect fertility primarily by altering the environment in which eggs and sperm develop, and modifying levels of hormones involved in reproductive processes.

   _____ True _____ False
3. Estrogen is produced by fat cells, the pituitary gland, and the testes.

   _____ True _____ False
4. The maturation of sperm takes 70 to 80 days.

   _____ True _____ False

Match the term listed in Column A with its definition from Column B.

Column A	Column B
5. _____ Puberty	a. A tissue about 12 mm in diameter formed from the follicle that contained the ovum prior to its release. It produces estrogen and progesterone.
6. _____ Corpus luteum	b. Biological ability to bear children.
7. _____ Subfertility	c. Generally defined as the loss of a conceptus in the first 20 weeks of pregnancy.
8. _____ Fecundity	d. The period in life during which humans become biologically capable of reproduction.
9. _____ Miscarriage	e. Menstrual cycles in which ovulation does not occur.
10. _____ Luteinizing hormone	f. A hormone that prepares the uterus for a fertilized ovum and helps to maintain a pregnancy; stimulates uterine lining buildup during menstrual cycle.
11. _____ Progesterone	g. Absence of menstrual cycle.
12. _____ Anovulatory cycles	h. A hormone that stimulates secretion of estrogen, progesterone, and testosterone and growth of the corpus luteum.
13. _____ Amenorrhea	i. Reduced level of fertility characterized by unusually long time to conception (over 12 months) or repeated early pregnancy losses.

14. Weight loss of 10 to 15 percent of body weight in normal-weight men, but not in normal-weight women, decreases fertility.

    _____ True _____ False
15. Both inadequate and excessive levels of body fat affect fertility.

    _____ True _____ False
16. Studies have consistently shown that high intakes of caffeine or coffee reduce fertility.

    _____ True _____ False
17. Although the incidence of neural tube defects in the United States declined post-folic acid fortification, some women are still at risk. Which of the following options represents a risk group for inadequate folate status and a neural tube defect affected pregnancy?
    a. Non-Hispanic Black women
    b. Non-Hispanic White women
    c. Asian American women
    d. Latinx women

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18. It is recommended that preconceptional women consume 400 mcg of folic acid from fortified foods or supplements, in addition to dietary folate from a variety of foods.

_____ True _____ False

19. Low energy intakes during the periconceptional period due to food restriction, weight loss, or eating disorders may modify gene functions in the embryo in ways that influence the future health of the offspring.

_____ True _____ False

20. Some individuals have an increased need for folate due to the gene variant 5,10-methylenetetrahydrofolate reductase that blocks the absorption of folate from food.

_____ True _____ False

21. Women should enter pregnancy with a good level of stored iron because it is easier to build up iron stores before than during pregnancy.

_____ True _____ False

22. The basic food groups presented in MyPlate are milk, meat and beans, vegetables, fruits, and breads and cereals.

_____ True _____ False

23. Menus generated by MyPlate include basic foods that are nutrient dense. The amounts of basic foods included in menus are primarily based on a person's age, sex, height, weight, and physical activity level.

_____ True _____ False

24. The current generation of oral contraceptives increases the risk of iron deficiency.

_____ True _____ False

25. Combination hormonal contraceptive use is associated with weight gain.

_____ True _____ False

26. Progestin-only contraceptives are related to increased blood glucose and LDL cholesterol levels.

_____ True _____ False

27. Women who received WIC services from one pregnancy through to a subsequent pregnancy appear to gain more weight during the subsequent pregnancy than do women who receive WIC benefits during pregnancy only.

_____ True _____ False

28. The CDC recommends that preconceptional health programs include education about weight, iron, and folate status; assessment of alcohol use; and services related to the management of disorders such as diabetes and celiac disease.

_____ True _____ False

29. Which of the following is *not* a step in the Nutrition Care Process?

a. Nutrition assessment
b. Nutrition diagnosis
c. Nutrition supplementation
d. Nutrition intervention

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Preconception Nutrition

Conditions and Interventions

Prepared by Judith E. Brown with Ellen Lechtenberg

Learning Objectives

After studying the materials in this chapter, you should be able to:

3.1 Compare the primary mechanisms that underlie the effects of obesity and underweight on fertility in women and men.

3.2 Identify two mechanisms by which a negative energy balance can influence fertility.

3.3 Illustrate two ways in which good blood glucose control during the periconceptional period can benefit fetal growth and development.

3.4 Cite three key components of the nutritional management of polycystic ovary syndrome (PCOS).

3.5 Summarize the major reasons why dietary control of phenylketonuria (PKU) is particularly important prior to pregnancy.

3.6 Describe three nutritional consequences of untreated celiac disease.

3.7 Identify four common symptoms of premenstrual syndrome and the proposed effects of dietary supplements on the symptoms of premenstrual dysphoric disorder (PMDD).

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Introduction

Conception and embryonic growth and development during the periconceptional period, placental and fetal development, and the course and outcome pregnancy are affected in multiple ways by the health and nutritional status women bring into pregnancy. Entering pregnancy in good nutritional and general health benefits placental, embryonic, and fetal growth and development, and woman's health, more than does initiating healthful practices during pregnancy. The same concept applies to women entering pregnancy with risk factors for disease development or preexisting conditions. The origins of adverse reproductive outcomes generally precede conception.[1,2,3]

This chapter addresses the roles of dietary intake and energy balance, weight status, eating disorders, diabetes, polycystic ovary syndrome, and other conditions related to nutrition on fertility and the course and outcome of pregnancy.

3.1 Weight Status and Fertility

Rates of reproductive health problems related to high levels of body fat are increasing in the United States and other countries along with rising rates of obesity. Rates of overweight and obesity in the United States now far exceed that for normal weight, whereas the prevalence of underweight is declining (Table 3.1).[4,5] Metabolic and hormonal changes induced by high or low levels of energy availability and body fat can adversely affect maternal health, fertility, embryonic growth and development, and infant outcomes.

Metabolic and hormonal changes induced by very high or low levels of body fat appear to be largely responsible for disruptions in fertility associated with obesity and underweight. These metabolic and hormonal changes influence fertility primarily by interfering with ovulation or sperm development.[4] Some of the metabolic and hormonal changes occurring with obesity and underweight prior to conception also influence pregnancy outcomes.[6,7]

Obesity, Body Fat Distribution, and Fertility

Obesity is now classified as a disease because it tends to shorten life span and is related to metabolic conditions that encourage development of health problems such as heart disease, type 2 diabetes, and impaired fertility. Overweight appears to impact fertility and pregnancy in women with metabolic abnormalities such as insulin resistance and chronic inflammation. Associations between overweight and poor health outcomes are much weaker than those for obesity in the absence of high levels of **intra-abdominal fat** (also called visceral fat).[8,9]

Obesity marked by excess intra-abdominal fat is related to insulin resistance, elevated levels of insulin, chronic inflammation, oxidative stress, and **metabolic syndrome**. Metabolic syndrome is referred to again in this and other chapters and is overviewed in the "In Focus: Metabolic Syndrome" box on the next page. These conditions can interfere with reproductive processes in women and men.[8] In women, elevated blood insulin levels reduce **sex hormone binding globulin** (SHBG) and that prompts the ovaries to increase production of testosterone. Excess testosterone disrupts egg development.[7] Ovulatory disorders produced by testosterone and other androgen excesses are related to irregular menstrual cycles, **anovulation**, and delayed time to conception. High levels of intra-abdominal fat in women contribute to anovulation, amenorrhea, delayed conception, and a reduced response to fertility treatments.[10]

Men with high levels of body fat can experience fertility problems because of hormonal changes related to the metabolism of testosterone in fat tissue. Fat tissue contains an enzyme (aromatase) that converts testosterone to estradiol, and this conversion may be abnormally high in people with high body fat. Consequently, men who experience obesity tend to have low testosterone and elevated estradiol levels. Increased blood levels of estradiol

Table 3.1 Prevalence of normal weight, overweight, obesity, and underweight in U.S. adult men and women[4,5]

	BMI, kg/m²	Men, %	Women, %
Normal	18.5 to 24.9	15	17
Overweight	25 to 29.9	34	27.5
Obese	30+	43	42
Severe Obesity	40+	7	11.5
Underweight	<18.5	1	2

intra-abdominal fat Fat located within the abdominal cavity around organs such as the liver, pancreas, and intestines. Intra-abdominal fat is referred to as visceral fat and is much more metabolically active than fat stored in other parts of the body.

metabolic syndrome A constellation of metabolic abnormalities that increase the risk of heart disease, hypertension, type 2 diabetes, and other disorders. Metabolic syndrome is characterized by insulin resistance, abdominal obesity, high blood pressure and triglycerides levels, low levels of HDL cholesterol, and impaired glucose tolerance. It is also called *insulin resistance syndrome*.

sex hormone binding globulin (SHBG) A protein that binds with the sex hormones testosterone and estrogen. These hormones are inactive when bound to SHBG, but are available for use when needed. Low levels of SHBG are related to increased availability of testosterone and estrogen in the body.

anovulation The absence of ovulation.

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In Focus Metabolic Syndrome

Definition: Metabolic syndrome is not a specific disease but rather a cluster of abnormal metabolic and other health indicators. It is diagnosed when three of the following five conditions exist:

1. Waist circumference 40″ in men, 35″ in women (These are an indicator of the presence of insulin resistance. Other population-based definitions of elevated waist circumference may also be used.)
2. Blood triglycerides 150 mg/dL or higher
3. HDL cholesterol, less than 40 mg/dL in men and 50 mg/dL in women
4. Blood pressure of 130/85 mm Hg or higher
5. Fasting blood glucose 100 mg/dL or higher[14,19]

Prevalence: It is estimated that 19.5 percent of adults ages 20–39 and 48.6 percent of adults over 60 years old in the United States[20] and 20 percent of adults and 40 percent of adults over 65 years old in Canada have metabolic syndrome.[16,21]

Major physiological aspects and consequences: The cluster of metabolic risk factors found in people with metabolic syndrome greatly increases the risk of development of cardiovascular disease and type 2 diabetes. Metabolic syndrome is also characterized by chronic inflammation and oxidative stress. Over time, chronic inflammation and oxidative stress cause damage to cells and body functions, and can impair reproductive functions.[22]

The first-line therapy for metabolic syndrome is lifestyle changes that emphasize dietary modifications, weight reduction, and exercise. Healthy dietary patterns rich in antioxidants, fruits, vegetables, whole-grain products, fiber, and low-fat dairy products are recommended. Such dietary patterns decrease inflammation, plasma triglyceride levels, body weight, plasma glucose levels, and blood pressure and increase HDL cholesterol levels.[19,20,22,23]

Risk factors: People with metabolic syndrome are often obese, have high levels of central body fat, and are insulin resistant. Specific gene variants appear to play important roles in the development of MS due to their influence on glucose utilization, insulin activity, chronic inflammation, and the formation of intra-abdominal fat stores.[24–28]

inhibit secretion of **luteinizing hormone (LH)** and **follicle stimulating hormone (FSH)** by the pituitary. Alterations in LH and FSH can lower testosterone synthesis. Low levels of testosterone decrease sperm production and promote infertility and subfertility.[11–14]

High levels of intra-abdominal fat in men are directly related to oxidative stress, a condition that can damage unsaturated fats and DNA. Specifically, oxidative stress can lead to the breakdown of polyunsaturated fatty acids in sperm membranes and damage sperm DNA. Damage to sperm can reduce fertility by impairing sperm functions and motility.[11] Insulin resistance and oxidative stress in men are also associated with impaired sexual functions.[12] Results from a large study recently found that paternal obesity may be associated with an increased risk of autism spectrum disorder in offspring.[15,16]

Oxidative stress can be decreased by the regular consumption of colorful vegetables, fruits, whole grains and whole grain products, and limited intake of sugar-sweetened beverages and foods.[17] Weight loss and moderate-intensity exercise, such as brisk walking, for 150 minutes a week also help reduce oxidative stress and inflammation.[18]

luteinizing hormone (LH) A hormone produced by the pituitary gland that stimulates ovulation, the development of the corpus luteum (which secretes progesterone), and the production of testosterone in men.

follicle stimulating hormone (FSH) A hormone produced by the pituitary gland that stimulates ovarian follicle growth and maturation, estrogen secretion, and endometrial changes characteristic of the first portion of the menstrual cycle in women. It stimulates sperm production in men.

Metabolically Healthy Individuals

Not all individuals with high or low levels of body fat are at risk of fertility problems. Whether individuals are at risk for health problems primarily depends on their metabolic profile. Metabolically healthy individuals, or those with no evidence of elevated blood pressure, glucose intolerance, abnormal blood lipid levels, or increased markers of inflammation and oxidative stress, are at lower risk of disease development than are metabolically unhealthy individuals. The prevalence of metabolic healthy individuals continues to decrease and are at very low levels. Data from the 2009–2016 NHANES survey published in 2018 reported only 12.2 percent of individuals living in the United States were metabolically healthy. If waist circumference is not included in the metabolic healthy criteria, 18 percent of Americans were metabolically healthy.[29] Some individuals within healthy weight ranges with excess abdominal

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Case Study 3.1 Weight Changes and Fertility Status

Miya and Mark are married with two delightful children, full-time jobs, and hectic schedules. Mark wants more children and Miya does not want additional children. In lieu of using standard contraception, Miya tries to avoid pregnancy by maintaining a weight of 210 pounds. At this weight, Miya seldom has a menstrual period and suspects that the odds of conception are slim. For 2 years, Miya's plan for avoiding conception worked.

Now that the children are older, Miya finds she has a bit of free time, which she uses to indulge in her love of swimming. Within months of beginning her program of swimming regularly, however, Miya abandons it. Her menstrual periods have become regular, and her contraception method is ineffective.

Miya's weight at 210 pounds has remained stable during the months she swam. It appears that her improved level of physical fitness and body fat has improved her fertility status.

Questions

1. What was likely the reason for Miya's infertility when she was inactive?
2. Give an example of a hormonal change that may have occurred after Miya began exercising regularly.
3. Name a possible health consequence related to Miya's high weight and lack of menstrual cycles.



Mia Gracia Tabili/Unsplash

fat can have metabolic disorders.[29–31] Less than 33 percent of individuals who are normal weight in the United States met metabolic healthy criteria. Only 8 percent of individuals who are overweight met metabolic healthy criteria and only 0.5 percent of individuals who are obese in the United States met metabolic healthy criteria.[29] Increasing physical fitness, even in the absence of weight loss, decreases the negative metabolic effects of obesity.

Weight Loss Benefits Fertility problems in individuals who are obese can often be reduced or eliminated by weight loss. It is the treatment of first choice.[32] Read more about an individual's experience with weight loss and fertility in Case Study 3.1. Weight reduction methods focused on behavioral goals and skills such as meal planning, food preparation, snack choices, and portion sizes, and regular participation in enjoyable physical activities are recommended.[33] Aerobic exercise, such as walking and jogging, appears to be particularly helpful for improving insulin resistance. Approaches to weight loss that stigmatize or shame individuals who are obese are counterproductive. Strategies that work should be supportive and individualized.[32]

Medications are available that may restore fertility in the absence of weight loss in obese individuals, and weight loss surgery may be indicated to recover fertility status if weight-loss efforts fail. Women who lose weight prior to pregnancy due to bariatric surgery are at lower risk of developing diabetes and hypertension during pregnancy than are women who are obese and do not lose weight.[34] They are, however, at increased risk of developing deficiencies of vitamins D, E, K, B_{12}, thiamin, riboflavin, niacin, folate, and of zinc, iron, and copper.[35]

Bariatric surgery prior to pregnancy increases the risk of nutrient deficiencies and low protein energy availability during pregnancy. If left unattended, malnutrition post-bariatric surgery can lead to undernourished, small-for-gestational-age newborns. Consequently, the nutritional status of women who have undergone weight loss surgery should be monitored and maintained by appropriate dietary intake and supplementation with highly absorbable forms of vitamin and mineral supplements such as chewable vitamins.[36] Conception is not recommended during the first year after bariatric surgery when weight loss is most rapid.[37]

3.2 Underweight and Fertility

Ovulatory processes are sensitive to energy balance and can be disrupted by a negative calorie balance, weight loss, and low levels of body fat. It is suggested that these effects are in place to prevent pregnancy in women who are malnourished and poorly prepared for the energy and nutrient costs of embryonic fetal growth and development.[38]

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Women in negative energy balance and those with low body mass indexes (BMIs) may develop anovulation and functional hypothalamic amenorrhea (FHA) due to impaired gonadotropin-releasing hormone (GnRH) secretion.[38,39] Underweight prior to conception also increase the chances of birth of preterm delivery and small-for-gestational-age newborns. The American College of Obstetrics and Gynecology recommends that preconceptional women be screened for underweight and obesity and that effective weight management services be made available before conception.[40,41]

Energy deficits that characterize hypothalamic amenorrhea appear to suppress the activity of **gonadotropin releasing hormone (GnRH)**. Other mechanisms in addition to suppression of GnRH may play a role in the development of anovulation in women with anorexia nervosa and the functional hypothalamic amenorrhea.[38]

Anorexia Nervosa, Bulimia Nervosa, and Fertility

Anorexia nervosa and **bulimia nervosa** are both related to the development of hypothalamic amenorrhea in some, but not all, women with these disorders.[42,43] Women with these conditions are more likely to experience lower fertility, miscarry, experience preterm delivery, and deliver newborns that are low birthweight (or less than 5.5 pounds or 2,500 g) than other women.[44,45] Very low levels of body fat are related to reduced estrogen production in fat cells. In addition, suppressed activity of GnRH leads to a decrease in estrogen production by the ovaries. Inadequate estrogen leads to the loss of bone mineral accretion and density, and increases the risk for osteoporosis and fractures.[40,46]

Ovulation and menstruation resume in most women with eating disorders with a return to normal eating behaviors and weight gain.[46] It is often difficult for women with eating disorders to achieve and maintain weight gain. Appropriate care entails the use of evidence-based practices utilizing an interdisciplinary group of experienced health professionals that includes a registered dietitian, nurse, social worker, and psychiatrist.[42,44] Additional information about eating disorders can be found in Chapter 15.

gonadotropin releasing hormone (GnRH)
A hormone produced in the hypothalamus that is responsible for the release of follicle stimulating hormone and luteinizing hormone by the pituitary gland.

anorexia nervosa An eating disorder characterized by extreme weight loss, poor body image, and irrational fears of weight gain and obesity.

bulimia nervosa An eating disorder characterized by recurrent episodes of rapid, uncontrolled eating of large amounts of food in a short period of time. Episodes of binge eating are followed by compensatory behaviors such as self-induced vomiting, dieting, excessive exercise, or misuse of laxatives to prevent weight gain.

Women, Exercise, and Fertility

Improved opportunities for female participation in sports and the military in recent decades have been followed by an upsurge in the number of women who are highly physically active.[46,47] Although this is a healthy trend, some who are involved in sports that emphasize a lean body type or vigorous physical training may be compromising their health (Photo 3.1).[46] Chronic energy deficits combined with very high levels of physical activity can place women at risk of developing functional hypothalamic amenorrhea.

Amenorrhea associated with very high physical activity levels appear to be triggered when energy intake is about 30 percent less than energy requirement.[46] This level of energy deficit leads to a loss of normal secretion of LH and FSH, a lack of estrogen production, and other hormonal changes seen in hypothalamic amenorrhea. Metabolic changes triggered by hormonal shifts result in decreased bone density and an increased susceptibility to stress fractures in affected athletes.[38,47]

Treatment of infertility related to physical activity-induced energy deficit focuses on improving energy balance through dietary changes, restoration of ovulation, and bone mass accretion.[47] Peak bone mass is established before age 30, so it is particularly important that interruptions in bone development be prevented or short in duration.[40] Vitamin D, calcium, and other supplements may be needed in addition to a balanced and adequate diet to facilitate bone development.[48] Restoration of energy balance can reverse disruptions in reproductive hormones and bone formation.[49–51]



Leonard Zhukovsky/Shutterstock.com

Photo 3.1 Female athletes most likely to develop the functional hypothalamic amenorrhea (FHA) participate in sports like gymnastics that emphasize a lean body.

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In Focus Diabetes

Definition: There are three major types of diabetes mellitus: type 1, type 2, and gestational. All types of diabetes are characterized by abnormally high blood glucose levels, or fasting levels of 126 mg/dL (7 mmol/L) or higher or HbA1c level of 6.5 percent.[52,53] People with diabetes are considered to be "carbohydrate intolerant" because carbohydrate consumption tends to raise blood glucose levels.

Type 1 diabetes mellitus is carbohydrate intolerance resulting from destruction of insulin-producing cells of the pancreas. Individuals with type 1 diabetes mellitus require an external supply of insulin. It is considered an **autoimmune disease**. About 5 to10 percent of cases of diabetes are of this type.[52]

Type 2 diabetes mellitus is carbohydrate intolerance due to the body's inability to produce enough insulin to meet the body's need for it. About 90 to 95 percent of cases of diabetes are of this type.[52]

Gestational diabetes is carbohydrate intolerance that begins or is first recognized during pregnancy. It is closely related to type 2 diabetes. (Additional information about gestational diabetes is presented in Chapter 5.)

Prevalence: Approximately 11 percent of U.S. adults have type 2 diabetes and less than 1 percent of youth and adults have type 1. Gestational diabetes is diagnosed in 2 to 10 percent of pregnancies.[53] Rates of gestational and type 2 diabetes are increasing worldwide due to escalating rates of obesity.[54,55]

Major physiological aspects and consequences: Major signs and symptoms of diabetes are frequent urination, increased thirst and fluid intake, increased appetite, and elevated blood glucose levels.

People with gestational diabetes or type 2 are generally overweight or obese and have insulin resistance. Additional risk factors for developing gestational diabetes are having gestational diabetes with a previous pregnancy, a family history of diabetes, advanced maternal age, and cigarette smoking.[56] Insulin resistance that develops with overweight or obesity partly originates from metabolic changes initiated in fat cells. High amounts of body fat are related to an increased release of fatty acids from fat cells into blood. High circulating levels of fatty acids stimulate the production of free radicals and other proinflammatory molecules and the development of oxidative stress and chronic inflammation. These and other changes are related to the development of insulin resistance in liver and muscle cells, excessive fat storage in the liver, and increased insulin output by beta cells of the pancreas. Over time, insulin resistance can lead to the exhaustion of beta cells and decreased insulin production, elevated blood glucose levels, and the onset of type 2 diabetes.[54,55]

Elevated blood glucose levels in people with diabetes have many adverse consequences in the short and long term. Such consequences can be limited or postponed by tightly managed blood glucose levels. Diabetes increases the risk of coronary heart disease, kidney disease, vision problems and blindness, nerve problems, and loss of limbs.

Types 1 and 2 diabetes are chronic diseases that require lifelong management. Patient education, nutritional support, and blood-glucose monitoring are important for long-term blood glucose control.[57] Some individuals with type 2 diabetes can reverse and control the disease through low calorie and carbohydrate restricted diets in addition to physical activity and weight loss.[58,59]

Risk factors: Exposure to certain infectious diseases, drugs, and other environmental agents can trigger the onset of type 1 diabetes in genetically susceptible individuals. Obesity, especially central obesity, is a primary risk factor for gestational and type 2 diabetes.[60]

The effect of high levels of physical activity on reproductive hormones in overweight women appears to be different from that experienced by lean athletes. Overweight women who engage in long-distance running, fast cycling, and other aerobic physical activities tend to experience improvements in reproductive hormone levels and increased fertility compared to overweight women who are sedentary.[38,49]

3.3 Diabetes Prior to Pregnancy

Poorly controlled blood glucose levels during the periconceptional period increase the risk of maternal and fetal complications during pregnancy. High blood glucose levels during the first 2 months of pregnancy are **teratogenic**; they are associated with a two- to threefold increase in

autoimmune disease Diseases that result from a failure of an organism to recognize its own constituent parts as "self." The organism attempts to defend itself from the perceived foreign substance through actions of its immune system. These actions can damage molecules, cells, tissues, and organs. Type 1 diabetes, lupus, and rheumatoid arthritis are examples of autoimmune diseases.

teratogenic Exposures that produce malformations in embryos or fetuses.

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the incidence of **congenital abnormalities** in newborns, including malformations of the pelvis, central nervous system (CNS), and heart. Exposure to high blood glucose during the first 2 months increases the risk of miscarriage.[61]

Management approaches to blood glucose control in diabetes depend, in part, on whether women have **type 1 diabetes** or **type 2 diabetes**. Once thought of as a disease of older adults, type 2 diabetes is becoming increasingly common in young adults and children due to the obesity epidemic. Approximately 90 percent of U.S. adults with type 2 diabetes are overweight or obese.[62] Background information on diabetes is presented in the "In Focus: Diabetes" box.

Nutritional Management of Diabetes Prior to Pregnancy

The main goals of the management of diabetes are blood glucose control, resolution of coexisting health problems, and health maintenance. The healthy dietary pattern recommended for people with diabetes is basically the same as for others. People with diabetes, however, are counseled to reduce intake of foods and beverages with added sugars.[59] It is not recommended that individuals with diabetes exclude all sources of sugar from their diets. Foods low in glycemic index and high in fiber are encouraged, as are brightly colored fruits and vegetables, whole grains and whole-grain products, low-fat dairy products, poultry, fish, dried beans, nuts, and seeds.[63] (Table 1.4 lists the GI of a variety of foods.) Foods with high GI tend to raise blood glucose and insulin levels more than do foods with low GI, and high-GI foods lead to more episodes of hyperglycemia (high blood glucose level) than do diets providing mainly low-GI carbohydrate foods. Ample intake of dietary fiber (14 g per 1,000 calories) appear to be particularly helpful for glucose control. Reduced-calorie diet and behavioral change plans should be included as part of the care for individuals with diabetes who would benefit from weight loss.[63]

Physical activity is generally part of a diabetes care plan because it improves blood glucose levels, physical fitness, and insulin utilization. Both strength and aerobic exercise are recommended. Individualized dietary and physical activity plans and follow-up care for individuals with diabetes should be provided by an experienced health-care team that includes a registered dietitian-nutritionist. The blood glucose response to diet composition varies somewhat among individuals, so dietary advice must be tailored for every person.[59,63]

There is no clear evidence of benefit from vitamin or mineral supplementation in people with diabetes who do not have underlying deficiencies. Routine supplementation with antioxidants, such as vitamin E, vitamin C, and beta-carotene, or with chromium is not recommended because of a lack of evidence of any benefit.[58]

Prevention of Gestational and Type 2 Diabetes

Gestational diabetes is considered a form of type 2 diabetes. Its occurrence during pregnancy substantially increases the risk that type 2 diabetes will occur later in life. Approximately 50 percent of women with a diagnosis of gestational diabetes will become a type 2 diabetic later in life.[53] In the best of all worlds, the risk of developing diabetes would be reduced prior to pregnancy. Several effective approaches to risk reduction have been identified for gestational diabetes and for type 2 diabetes.

Weight loss if overweight, increased dietary fiber intake, consumption of a healthy dietary pattern, and regular exercise prior to pregnancy are related to a reduced risk of gestational diabetes. Weight loss should be achieved before pregnancy because it is not recommended during pregnancy.[64] Regardless of prepregnancy weight status, women adhering to a healthy dietary pattern are less likely to develop gestational diabetes than women who consume a typical Western-type diet high in processed snack foods and meat products, added sugars, fried foods, and too few plant foods.[65]

The risk of type 2 diabetes can be decreased by weight loss, low-glycemic-index sources of carbohydrates, exercise, and consumption of a healthy dietary pattern.[28,63] A large study that took place over a 3-year period found that losses in body weight of about 7 percent of original weight combined with 150 minutes per week of exercise reduced the risk of type 2 diabetes development by 50 percent.[66–68] Dietary patterns containing primarily low-glycemic-index sources of carbohydrates such as whole grains and whole-grain products, vegetables, and fruits are associated with lower fasting blood glucose levels. Exercise improves physical fitness levels, general health, and insulin sensitivity.[69–71] Factors associated with reduced risk of developing gestational diabetes, type 2 diabetes, or both are summarized in Table 3.2.

congenital abnormality A structural, functional, or metabolic abnormality present at birth. Also called congenital anomalies. These may be caused by environmental or genetic factors, or by a combination of the two. Structural abnormalities are generally referred to as congenital malformations, and metabolic abnormalities as inborn errors of metabolism.

type 1 diabetes A disease characterized by high blood glucose levels resulting from destruction of the insulin-producing cells of the pancreas. This type of diabetes was called juvenile-onset diabetes and insulin-dependent diabetes in the past, and its official name is type 1 diabetes mellitus.

type 2 diabetes A disease characterized by high blood glucose levels due to the body's inability to use insulin normally, or to produce enough insulin. This type of diabetes was called adult-onset diabetes and non-insulin-dependent diabetes in the past. Its official name is type 2 diabetes mellitus.

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Table 3.2 Factors associated with reduced risk of developing gestational diabetes, type 2 diabetes, or both[56,58,59,62,64,66]

• Weight loss (if needed)
• Regular exercise
• Healthy dietary pattern
• High fiber intake
• Intake of low GI carbohydrate sources
• Regular vegetable and fruit consumption

3.4 Polycystic Ovary Syndrome and Fertility

Case scenario: Lupe is a 28-year-old woman who is 5 ft 3 in. tall and weighs 208 pounds. She and her husband want to start a family, but her highly irregular periods and a failure to become pregnant prompted her to seek medical care. At the clinic it is determined that Lupe's waist circumference is 38 in. and her BMI is 37 kg/m^2, that she experiences five or six periods a year, and dislikes the course hair that grows on her face and lower back. This is not the first time she has sought medical care to find a solution to her conditions, it is her third (Table 3.3). Finally, after her fourth attempt to get an answer, and after other possibilities are excluded. Lupe is diagnosed as having **polycystic ovary syndrome,** or **PCOS**.

PCOS is an underdiagnosed condition and a common cause of fertility problems in women.[72] It is labeled "polycystic ovary syndrome" not because the ovaries cause the infertility, but because one or both ovaries have a covering that contains immature ova in sacs. The ovaries may appear yellowish (PCOS used to be called the "golden ovary" syndrome).

Infertility in women with PCOS is primarily due to the absence of ovulation. The absence of ovulation is related to multiple genetic factors and environmental influences that predispose women to produce high levels of androgens, particularly testosterone. Excess testosterone interferes with many body processes, including ovulation and glucose utilization, and is associated with insulin resistance, abnormal blood lipid levels, fatty liver disease, weight gain, and excess hair (as shown in Photo 3.2), and acne development.[73,74] Metabolic changes occurring with PCOS predispose the body to store abdominal body fat and accumulate fat in the liver, both of which promote insulin resistance, high blood levels of insulin, and overweight and obesity.

Table 3.3 Top concerns of women with PCOS[72,78,79]

• Difficulty in losing weight
• Irregular menstrual cycles
• Lack of conception
• Unwanted, excess hair growth (Photo 3.2)
• Difficulty in obtaining a diagnosis
• Dissatisfaction with health-care services received



John Radcliffe Hospital/Science Source

Photo 3.2 The appearance of hirsutism (abnormal facial or body hair) in a woman with PCOS.

These conditions, in turn, increase the risk of hypertension, type 2 diabetes, and cardiovascular disease.[73,74]

More than half of women with PCOS are overweight or obese, but even in women with PCOS who are normal weight, levels of intra-abdominal fat are usually high.[73] Some women with PCOS have excess body hair (also known as hirsutism; see Photo 3.2), acne, high blood levels of insulin, triglycerides, and androgens, and low levels of HDL cholesterol (Table 3.4). PCOS appears to have a genetic component,

Table 3.4 Diagnostic criteria and common clinical signs associated with PCOS[73,78]

Diagnostic Criteria
Two of the following three:
• Hyperandrogenism: Androgen excess characterized by excessive levels of androgens (primarily testosterone) that causes hirsutism, or the presence of excessive amounts of dark, course hair on the face, chest, and back of women, and acne
• Ovulatory dysfunction: Infrequent or irregular ovulation
• Polycystic ovaries, identified by the presence of a high number of immature eggs surrounded by fluid-filled sacs on the ovary
Other Common Characteristics
• Excess abdominal fat
• Overweight or obesity
• Insulin resistance
• Impaired glucose tolerance
• Abnormal blood levels of LDL and HDL cholesterol, and higher levels of triglycerides

polycystic ovary syndrome (PCOS)
(polycysts = many cysts; i.e., abnormal sacs with membranous linings). A disorder primarily characterized by androgen excess (particularly testosterone), polycystic ovaries, and ovulatory dysfunction.[72]

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and its development is influenced by environment–gene interactions.[6] It tends to run in families where women have a history of infertility, menstrual problems, type 2 diabetes, central obesity, and hirsutism. In utero exposures that affect fetal gene programming may be a factor in its development. It appears that the onset of PCOS is related to specific gene variants that lead to overproduction of androgens such as testosterone.[7] PCOS is sometimes difficult to diagnose (and may therefore not be treated) because signs and symptoms of the disorder vary among individuals.

Although obesity does not cause PCOS, it exacerbates reproductive and metabolic problems associated with it. Rates of PCOS in teens and women increase with the rise of overweight and obesity. Women with PCOS are at increased risk of spontaneous abortions, gestational and type 2 diabetes, hypertension, and cardiovascular disease.[75]

Nutritional Management of PCOS

A primary goal of PCOS treatment is to increase insulin sensitivity through healthy dietary patterns, weight loss, and regular exercise. Weight loss as low as of 5 percent of initial body weight has been found to restore regular menstrual periods or to improve the response to ovulation-induction therapies. It improves insulin sensitivity, and helps lower blood glucose, insulin, and testosterone levels; and supports the normalization of ovulation.[73,76,77] Most women with the syndrome conceive and bear children.[72,73] Care must be taken to individualize eating and exercise plans if weight loss is to succeed. PCOS is a long-term health problem that requires a sustainable approach to weight loss and exercise. In addition, women may benefit from knowing more about PCOS, long-term health risks, and why weight loss and exercise may be needed.[73,78–81]

3.5 Phenylketonuria (PKU)

Phenylketonuria (also called hyperphenylalaninemia) is the most frequently inherited disorder of amino-acid metabolism and is an important, preventable cause of intellectual disability. It occurs in roughly 1 in 10,000 individuals.[82]

Phenylketonuria (PKU) derives its name from the characteristic presence of phenylalanine in the urine of people with this condition. PKU is an inherited problem that causes elevation in blood phenylalanine levels due to very low levels or lack of the enzyme phenylalanine hydroxylase. Lack of this enzyme diminishes the conversion of the essential amino acid phenylalanine to tyrosine, a nonessential amino acid, and causes phenylalanine to accumulate in blood. High levels of phenylalanine impair nerve functions and interfere with amino acid transport.[83]

phenylketonuria (PKU) An inherited error in phenylalanine metabolism most commonly caused by a deficiency of phenylalanine hydroxylase, which converts the essential amino acid phenylalanine to the nonessential amino acid tyrosine. Also called hyperphenylalaninemia.

If present during early pregnancy, high levels of phenylalanine accumulate in the embryo and fetus and impair normal CNS development. Elevated phenylalanine levels in the first 8 weeks of pregnancy increase the risk of heart defects. The risk increases if high blood levels of phenylalanine are combined with low-protein diets early in pregnancy.[84] Untreated women with PKU have a 92 percent chance of delivering a newborn with intellectual disabilities and a 73 percent chance that the infant will be born with an abnormally small head (microcephaly). Infants born to women with high blood levels of phenylalanine during pregnancy are at elevated risk of seizures, hyperactivity, and abnormal behavioral patterns later in life.[85–88]

Not all infants born to a parent with PKU inherit the disorder, and some infants inherit it from parents who do not have PKU. It is important that infants born with PKU be identified and started on low-phenylalanine formula (Photo 3.3) as soon after birth as possible. Because phenylalanine is an essential amino acid, some phenylalanine must be included in the diet. To meet this need, the phenylalanine-free formula will be mixed with an amount of breast milk or formula that supplies enough phenylalanine to meet needs while controlling blood phenylalanine levels. Table 3.5 presents a condensed story about the journey of an individual born with PKU that was identified late and inadequately controlled. Individuals born with PKU who adhere to an adequate, low-phenylalanine diet during



Courtesy of Mead Johnson & Company, LLC

Photo 3.3 An example of a phenylalanine-free formula.

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Table 3.5 One Person's PKU Experience

Margaret was a healthy newborn but during her first year of life she started to experience seizures and difficulty in standing and walking. When she was 13 months old, she was diagnosed with PKU and started on a low-phenylalanine diet. Her development improved until the age of 8 years, when she was taken off the diet. It was reasoned that she no longer needed the low-phenylalanine diet because "her brain had grown." Around the age of 19, Margaret became violent, destructive, hysterical, and self-abusive. Her family put her back on the PKU diet and, although she continued to have seizures and continued to have significant intellectual disabilities, her behaviors and quality of life improved.[86]

childhood and later in life tend to develop normally or at levels that are somewhat below normal (Photo 3.4).[83,84]

People with undiagnosed PKU may self-select low-protein foods because meat and other rich sources of protein make them light-headed and easily confused. They may find it difficult to comprehend all the information they receive after the inborn error is diagnosed.[89,90]

Maternal PKU

In the past, it was thought that children with PKU could safely go off the PKU diet after the brain developed. Later, it was made abundantly clear that PKU diets should be maintained and levels of phenylalanine periodically tested throughout life.[82,84,85] Women with PKU who are not on a PKU diet before pregnancy are at risk for a condition called maternal PKU. Uncontrolled PKU in women represents risks for the fetus during pregnancy, even if the fetus did not inherit the disorder. The extent of the harm caused to the fetus increases with high maternal phenylalanine levels. Adverse effects on the fetus can be minimized if maternal phenylalanine levels are well controlled before and throughout pregnancy, and energy and nutrient needs of the mother are met.[81,85,90]

In the 1960s, the United States adopted newborn screening programs that test infants for a variety of genetic disorders including PKU.[91] States track individuals testing positive for PKU to ensure they are provided with medical and nutrition services, a prescription low-phenylalanine formula, and are made aware of the potential adverse effects of uncontrolled PKU throughout pregnancy. Not all women are able to follow the diet, however, because it is expensive and unpalatable to them, while others may get confused and have trouble staying on the diet.[91] Many specialty formulas and food products low in phenylalanine and often fortified with tyrosine, vitamins, and minerals are commercially available in low-phenylalanine breads and other bakery products, pastas, cheese, snack foods such as chips, and baking mixes. Alternatives to diet therapy for PKU management are being developed and tested. In the future, it is likely that PKU will be managed largely by techniques such as cell transplantation, gene therapy, or injectable forms of the missing enzyme.[92]



Andi Berger/Shutterstock.com

Photo 3.4 You can't pick a person with well-controlled PKU out of a crowd.

Nutritional Management of PKU

PKU can be successfully managed by a low-phenylalanine diet, instituted and monitored with the help of an experienced registered dietitian-nutritionist, nurses, and physicians. PKU diets are individualized based on blood phenylalanine response to protein foods. Successful PKU diets maintain blood concentrations of phenylalanine in the range of 120 to 360 μmol/L (2–6 mg/dL).[90] Table 3.6 shows a diagram of a target to visualize foods allowed on the PKU diet. Foods closest to the center are encouraged, and foods on the outer edge of the target are not allowed on the due to their high phenylalanine content.[88] High phenylalanine protein foods

Table 3.6 This target is an easy way to visualize the foods allowed on a PKU diet[88]



The phenylalanine-free formula, such as Phenyl-Free, is the center of the target diet.

As the foods get farther away from the bull's-eye, they are higher in phenylalanine.

The foods outside the target are not included in the low-phenylalanine meal plan.

Source: Available at https://depts.washington.edu/pku/adults/diet.html.

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such as meat, fish, eggs, and wheat are excluded from the diet. Given the regular intake of fortified PKU formulas and foods, almost all individuals with PKU sustain a near normal nutrient status. However, 14 to 20 percent of individuals have been identified as having low plasma concentrations of eicosapentaenoic acid, vitamin D, and selenium. Assuring adequate intake of food sources of these nutrients is recommended over the use of supplemental nutrients.[92]

The PKU diet is beneficial throughout life, but it is critical that it be adhered to prior to conception and maintained throughout pregnancy. It usually takes about 4 to 6 months to learn and implement the PKU diet and to lower blood phenylalanine levels.[92–94] "How to" advice on the diet is available at many websites such as the National PKU News. This site covers the details about the PKU diet and its implementation, and lists suppliers of low-phenylalanine foods.[95]

3.6 Celiac Disease

Celiac disease, highlighted in the "In Focus: Celiac Disease" box on page 82, is related to somewhat higher rates of infertility and to substantially higher rates of subfertility.[96] In men, untreated celiac disease is related to alterations in the actions of androgens, delayed sexual maturation, and hypogonadism. Hypogonadism is marked by a deficiency of sex hormones, and poor development and functioning of the reproductive system. In women, untreated celiac disease is associated with amenorrhea, increased rates of miscarriage, fetal growth restriction, low birth-weight deliveries, and a short duration of lactation. It is hypothesized that the effects of celiac disease on reproductive functions in men and women is related to malabsorption-induced deficiencies of nutrients such as zinc, folate, and iron, and direct effects of inflammation on intestinal and other tissues.[97–99] Table 3.7 lists vitamin and mineral deficiencies and other potential health consequences of untreated celiac disease. Normal reproductive functions generally return after celiac disease has been stabilized with a nutritionally adequate gluten-free diet.[98,99]

Not all individuals with celiac disease have overt symptoms, so it may be missed as an underlying cause of infertility.[97] It should be considered in unexplained cases of infertility, early pregnancy loss, and poor pregnancy outcomes.[98,99] Case Study 3.2 describes the experience of a woman ultimately diagnosed with celiac disease.

Table 3.7 Vitamin and mineral deficiencies and other health consequences that may occur in people with untreated celiac disease[6,96]

Vitamin Deficiencies	Other Potential Health Problems
Folate	Lactose maldigestion, intolerance
Vitamin B_{12}	Weight loss
Vitamin A	Anemia
Vitamin D	Osteoporosis
Vitamin E	Subfertility
Vitamin K	Growth failure (in children and adolescents)
	Irritable bowel disease
Mineral Deficiencies	
Calcium	
Iron	

Case Study 3.2 Celiac Disease

Chloe, age 30, has not had a period for over 2 years. Her gynecological exam turns up no abnormalities, but the hormones she is given to stimulate her menstrual periods do not work. Since the age of 10, Chloe has had painful stomach cramps, frequent diarrhea or constipation, and periodic iron-deficiency anemia. Multiple visits to doctors have failed to find the cause of Chloe's health problems. At around the age of 20, Chloe had begun to wonder if she was a medical anomaly or a hypochondriac.

Still bothered by her health problems and soon to be married, Chloe seeks care again after reading an article on celiac disease. This time she is seen by a nurse practitioner who refers Chloe to a gastroenterologist who performs lab work and a biopsy to check for celiac disease. The biopsy confirms celiac disease and Chloe is referred to a registered dietitian, who provides gluten-free diet education and menu ideas for Chloe. The dietitian also addresses vitamin and mineral deficiencies identified in Chloe's bloodwork that were due to a delayed diagnosis of celiac disease.

After faithfully following the diet for a week, Chloe feels better. The cramps, diarrhea, and constipation are much improved, and later on, her menstrual cycles return. It takes approximately 3 to 6 months of following the gluten-free diet for Chloe's intestines to return to a healthy state.

Questions

1. What should have been the first clue that Chloe might have celiac disease?
2. What facts provide other clues to the possibility of celiac disease?
3. How long will Chloe have to stay on a gluten-free diet?



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Nutritional Management of Celiac Disease

Treatment of celiac disease focuses on the goals of elimination of gluten from the diet, correction of vitamin and mineral deficiencies, and the long-term maintenance of health. The cornerstone of treatment—elimination of gluten—can be challenging. Gluten is found in a variety of nongrain foods, including hot dogs, deli meats, some vitamin and mineral supplements, flavored potato chips, bouillon, and salad dressing. Table 3.8 lists foods that contain gluten and others that do not. An example of a gluten-free 1-day diet for an adult with celiac disease is shown in Table 3.9.

People with celiac disease are generally avid food-label readers and eventually become skilled at selecting gluten-free foods. In 2008, the Food and Drug Administration (FDA) started allowing gluten-free foods to be labeled "gluten-free" if they qualify according to a standard definition. The FDA updated this rule in 2013 to define foods labeled as "gluten-free." This final rule has standardized labeling, helping individuals with celiac disease feel confident in purchasing these foods that meet all the regulations of the rule.[100] In 2020, the FDA issued a final rule on gluten-free labeling of hydrolyzed or fermented foods. These foods must be compliant with the 2013 final FDA labelling rule in order to use gluten-free on the label.[100] The Gluten-Free Certification Organization (GFCO) tests food products for gluten content and certifies them with a GF mark (Photo 3.5) if found to contain less than 10 ppm, or 3 mg, gluten per serving. Although the vast majority of foods labeled "gluten-free" meet FDA standards,[101] manufactured rice-based foods labeled "gluten-free" have been found to be contaminated with arsenic and mercury.[102]

Table 3.8 Examples of foods that do or do not contain gluten

Gluten-Containing Foods	Gluten-Free Foods[a]
Beer, ale	Fruits
Barley	Vegetables
Broth, bouillon powder/cubes	Dried beans
Brown rice syrup	Amaranth
Bulgur	Cassava, millet
Commercial soups, salad dressings	Grits, corn, cornmeal
Breads, cereals, pastas	Quinoa
Imitation seafood	Oatmeal (gluten-free)
Cakes, pies, cookies	Fats
Processed meats	Fresh meats, fish
Soy sauce	Soy flour, cereals, tofu
Wheat starch	Rice, wild rice
Pizza	Eggs
Macaroni and cheese	Nuts, seeds
Seasonings	Cheese (not processed)
Marinades, gravies	Popcorn
Rye-containing products	Milks
Vegetarian meat substitutes	Chips (100% corn, potato)
Flavored-rice packaged products	

[a]Assumes foods have not been contaminated with gluten during processing and are free of gluten-containing ingredients.

Table 3.9 Example of 1 day's diet and snack options for an adult with celiac disease

Breakfast	Dinner
Gluten-free bagel with nut butter Sliced bananas in yogurt Tea	Lamb stew (thickened with potato starch) with carrots and lentils Rice Gluten-free cake Low-fat milk
Lunch	**Snack Options**
Gluten-free pasta salad with chicken, broccoli, and tomatoes Oil and vinegar dressing Gluten-free roll with margarine Fresh fruit Low-fat milk	Popcorn Spring rolls with rice paper Ice cream Fruit Dark chocolate Gluten-free cookies String cheese Rice cakes

Evidence-Based Nutrition Practice Guidelines for Celiac Disease Evidence-based nutrition practice guidelines and the Nutrition Care Process for celiac disease have been developed by the Academy of Nutrition and Dietetics.[103] Major components of nutrition care services and the Nutrition Care Process are highlighted in Table 3.10. Monitoring individuals for abnormalities in nutritional status that may impact reproductive outcomes is an important part of the Nutrition Care Process for celiac disease.

Wheat Intolerance Syndrome Wheat intolerance syndrome (formerly called "non-celiac gluten sensitivity") appears to be related to the ingestion of wheat but not to the gluten component of wheat. Table 3.11 summarizes



Photo 3.5 The Gluten-Free Certification Organization tests and certifies products as gluten-free and awards qualifying products this mark.

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In Focus Celiac Disease

Definition: An autoimmune disease characterized by chronic inflammation of the small intestine due to an inherited sensitivity to the gliadin portion of gluten in wheat, rye, and barley. It is associated with the malabsorption of nutrients, nutrient deficiencies, and an increased risk of other immune disorders. Also called gluten-sensitive enteropathy, celiac sprue, and nontropical sprue.[104]

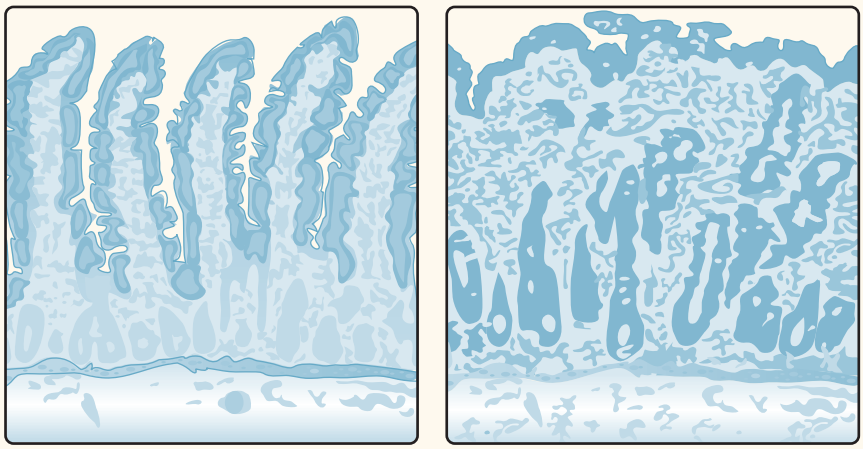
Diagnosis: Blood tests for celiac antibodies and genetic markers of celiac disease are used to help identify the presence of celiac disease. The gold-standard diagnostic test for celiac disease, however, is small bowel biopsy and examination of cells for signs of damage due to the disease.[105] The test has to be undertaken while individuals are consuming their normal diet and not a gluten-free one. Removal of gluten from the diet corrects intestinal cell damage and may lead to an incorrect diagnosis.[105,106]

Prevalence: Celiac disease occurs in approximately 1 percent of the population of the United States and appears to be increasing.[105,107] It is three times more common in women than men, and most likely to occur in non-Hispanic, White Americans.[108,109] The incidence of celiac disease appears to be increasing. Although awareness of, and screening for, celiac disease is increasing, far more individuals have the disease than have been diagnosed with it. It is estimated that only 17 percent of individuals with celiac disease in the United States have been diagnosed.[10,110]

Major physiological aspects and consequences: The presence of gliadin in the small intestine triggers an autoimmune response that causes an inflammatory reaction to occur in the inside lining of the small intestine. Over time, the inflammation causes the lining of the small intestine to become flattened and to absorb nutrients poorly (Figure 3.1). The damage produced by chronic inflammation in the small intestine may lead to a variety of vitamin and mineral deficiencies and other health consequences.

Symptoms of celiac disease range from none or very mild to severe and vary by age and sex. Diarrhea, abdominal pain, nutrient malabsorption, bloating, weight loss, iron-deficiency anemia, infertility, fatigue, and growth failure in children often characterize the disease. Many cases of celiac disease are clinically silent—presenting no clear, related symptoms.[110] Long-standing, untreated celiac disease predisposes individuals to other autoimmune diseases. The only effective treatment is a lifelong gluten-free diet.[107]

Risk factors: The primary risk factor for celiac disease is a genetic predisposition toward reacting to gliadin as a foreign protein.[104] Repeated exposure to specific viral infections may also trigger the onset of the disease in genetically susceptible people.[108] It is possible that antiviral therapy will be available in the future that can prevent the infection and the development of celiac disease.



(a) (b)

Figure 3.1 Sections of the small intestine showing normal villi structures of a person without celiac disease (a) and the flattened villi that develops in people with untreated celiac disease (b).

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Table 3.10 Key features of the Nutrition Care Process for individuals with celiac disease[103]

A.	Nutrition Assessment
1.	Assessment of food/nutrition-related history • Food and nutrient intake with focus on vitamins and minerals listed in Table 3.7 • Knowledge, skills, attitudes about celiac and dietary change • Access to food
2.	Assessment of biochemical data and medical results • Severity of intestinal lining damage • Presence of anemia, osteoporosis, other diseases
B.	**Nutrition Intervention**
1.	Provide education and guidance on nutritionally adequate, gluten-free diet
2.	Advise on the use of gluten-free multivitamin and mineral supplement as required
3.	Provide resources and education on label reading, food cross-contamination, and support groups
C.	**Nutrition Monitoring and Evaluation**
1.	Monitor dietary intake, gluten intake from all sources, celiac antibody levels
2.	Monitor persistent gastrointestinal symptoms not eliminated by a gluten-free diet, coordinate care
3.	Monitor nutrition risks for poor pregnancy outcomes

characteristics of each of these conditions.[106,108,111–115] Diagnostic criteria for and mechanisms involved in wheat intolerance syndrome require additional study because gaps in knowledge about this condition exist and there are no diagnostic standards. People reporting the condition do not have celiac disease but often report that a gluten-free diet helps them feel better.[99,113] Wheat-free and gluten-free diets are becoming increasingly popular in the United States and are most often followed by individuals who have not been diagnosed with celiac disease.[112]

3.7 Premenstrual Syndrome

It wasn't until 1987 that PMS, or **premenstrual syndrome**, moved from the psychogenic disorder section of medical textbooks to chapters on physiologically based problems. PMS is characterized by life-disrupting physiological and psychological changes that begin in the **luteal phase** of the menstrual cycle and end with menses (menstrual bleeding). Symptoms of PMS disappear within 2 days after the onset of menses and return with the next luteal phase. It is a fairly common condition, affecting 20 to 40 percent of menstruating women.[116,117]

A standardized, self-administered questionnaire about symptoms completed for three menstrual cycles is the primary tool used for the diagnosis of PMS. Individuals reporting the presence of one or more of the behavioral and of the physical symptoms shown in Table 3.12 during the 5 days before menses over three consecutive menstrual cycles meet the criteria for the diagnosis PMS.[118]

Table 3.11 Characteristics of celiac disease and of wheat intolerance syndrome[106,108,111–115]

Celiac Disease
• Diagnosed in 1% of people in the United States. Up to 75% of cases may be unrecognized. Rates are increasing for reasons that are not yet clear.
• It is a gluten-related autoimmune disease characterized by specific genotypes and environmental exposures.
• Recent evidence indicates that exposure to a particular type of viral infection may prompt celiac development by modifying the body's immune response to gluten.
• Intestinal and other body tissue damages related to celiac disease are primarily due to the effects of inflammation.
• Onset of symptoms typically gradual, taking months to years.
• Symptoms vary. They range from gastrointestinal symptoms such as abdominal pain, diarrhea, or constipation, to low energy, poor growth, or delayed puberty.
• Diagnostic standard calls for a small bowel biopsy while the person is not on a gluten-free diet.
• Symptoms resolve with a gluten-free diet.
• The popularity of this type of diet demonstrates its acceptance.
Wheat Intolerance Syndrome
• Does not involve gluten sensitivity or intestinal lining damage. Individuals with this disorder do not have celiac disease.
• Cause is unknown but appears to be related to sensitivity to one or more components of wheat.
• Is associated with symptoms such as fatigue, diarrhea, "foggy mind," and muscle pain that appear to be related to the ingestion of wheat-containing foods.
• Symptoms improve if wheat is excluded from the diet.
• Diagnostic standards are not available, so the prevalence is unknown.

Premenstrual dysphoric disorder (PMDD) is a severe form of PMS that occurs in about 5 percent of menstruating women.[119] It is characterized primarily by marked mood swings, anxiety, irritability, depression, disruptions of personal relationships, and physical symptoms (breast tenderness, headache, joint or muscle pain). Some women with PMDD develop a marked increase in appetite,

premenstrual syndrome (*premenstrual* = the period of time preceding menstrual bleeding; *syndrome* = a constellation of symptoms). A condition occurring among women of reproductive age that includes a group of physical and psychological symptoms with onset in the luteal phase and subsiding with menstrual bleeding. Premenstrual dysphoric disorder (PMDD) is a severe form of PMS.

luteal phase The second half of the menstrual cycle (usually days 14–28) that occurs after ovulation.

premenstrual dysphoric disorder (PMDD) A severe form of PMS characterized by disabling irritability, sadness, anxiety, depression, and various other symptoms. It begins during the luteal phase of the menstrual cycle and ends with menstrual bleeding.

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Table 3.12 Common symptoms of PMS[116]

Physical	Psychological
• Tender breasts	• Angry outbursts
• Abdominal bloating	• Depression
• Swelling	• Irritability
• Headache	• Confusion
	• Anxiety
	• Social withdrawal

overeat, and crave certain foods. PMDD is diagnosed when five or more of the common symptoms of PMDD occur during most menstrual cycles.[116,117]

The cause of PMS and PMDD are not entirely clear. However, the symptoms appear to be related to enhanced responsiveness to normal changes in ovarian hormone levels that produce ovulation. The increased sensitivity appears to be related to the presence of specific gene types that modify the body's normal response to estrogen and progesterone.[120–122]

Treatment of PMS

A number of studies have examined relationships between PMS and PMDD and nutritional status and dietary intake. Given the available evidence, however, no firm conclusions about dietary characteristics or nutritional status and the risk or treatment of symptoms can be made. Nutrition advice given to women with PMS or PMDD includes consuming a healthy dietary pattern, maintaining a healthy weight range, and exercise.[123,124]

Treatment recommendations for PMS and PMDD include supplementation with B6 (100 mg/day) and calcium (500 mg/day). These two nutrients appear to help relieve certain symptoms of PMS.[125] Several herbal remedies, including St. John's wort and Gingko biloba, are sometimes recommended to relieve specific symptoms. Use of hormones and drugs that suspend ovulation by modifying levels of estrogen and progesterone or address specific symptoms represent available treatments.[126–131]

Key Points

1. Nutrition and other lifestyle changes are a core component of the treatment of a variety of common health problems of women and men prior to conception.
2. Nutrition and health status prior to pregnancy and during the periconceptional period influences embryonic and placental development, the risk of complications during pregnancy, and infant outcomes.
3. Obesity is related to a number of hormonal and metabolic changes that may compromise fertility and health status in men and women.
4. Modest levels of weight loss in obese women and men, and weight gain in underweight individuals, improve fertility.
5. Rates of diseases and disorders associated with obesity such as metabolic syndrome, polycystic ovary syndrome, gestational diabetes, and type 2 diabetes are increasing in the United States and other countries. Obesity-related health problems affecting fertility and the course and outcome of pregnancy are being seen increasingly in clinical practice.
6. Chronic energy deficits in women due to excessive levels of physical activity, eating disorders, and low-calorie diets prior to pregnancy reduce fertility.
7. Insulin resistance is a key feature of obesity, gestational and type 2 diabetes, metabolic syndrome, and polycystic ovary syndrome.
8. Some obese and underweight individuals are metabolically healthy.
9. Energy deficits in individuals with hypothalamic amenorrhea, eating disorders, and the functional hypothalamic amenorrhea are related to reduced fertility.
10. Healthful dietary patterns that provide sufficient calories to meet a person's energy need to play a key role in recovery from functional hypothalamic amenorrhea.
11. PKU is a genetic disorder that causes blood phenylalanine levels to rise to toxic concentrations in untreated individuals. Untreated PKU can produce malformations, neurological disorders, and severe intellectual disabilities in children and adults. It is treated with a low-phenylalanine diet for life.
12. Untreated celiac disease is related to multiple vitamin and mineral deficiencies, impaired fertility, fetal growth disruptions, and other adverse pregnancy outcomes. Standard treatment for celiac disease is a gluten-free diet.

Review Questions

1. Most of the treatments for PMS are based on the prevention of ovulation.

   _____ True _____ False

2. A wide variety of dietary supplements, ranging from evening primrose oil to St. John's wort, have been found to effectively and safely treat the symptoms of PMS.

   _____ True _____ False

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3. The presence of excess intra-abdominal fat is related to insulin resistance, elevated levels of insulin, chronic inflammation, oxidative stress, and the metabolic syndrome.

_____ True _____ False

4. Obesity is related to impaired fertility and chronic inflammation in men only.

_____ True _____ False

5. Weight loss surgery is the recommended, first-line treatment for obesity in adults.

_____ True _____ False

6. Men with high amounts of body fat tend to have low levels of testosterone and elevated estradiol levels. These hormonal changes do not appear to effect sperm production, however.

_____ True _____ False

7. Caloric restriction that produces a negative energy balance in underweight and normal weight, menstruating women is related to the development of hypothalamic amenorrhea.

_____ True _____ False

8. Energy deficits that characterize functional hypothalamic amenorrhea appear to suppress the activity of gonadotropin releasing hormone (GnRH).

_____ True _____ False

9. A lack of body fat and low levels of estrogen can lead to the loss of bone mineral accretion and density, and increases the risk for osteoporosis and fractures.

_____ True _____ False

10. Ovulation and menstruation resume in most women with eating disorders after healthful eating behaviors and weight gain occur.

_____ True _____ False

Questions 11–14 refer to the following scenario and appropriate components of the nutritional management of type 2 diabetes.

Scenario: Lois was diagnosed with type 2 diabetes two months before she planned to become pregnant. To get her blood glucose under control before pregnancy, Lois worked with a dietitian-nutritionist who specializes in diabetes, and together they developed a plan to reduce Lois's blood glucose levels.

11. As part of the plan, Lois would have to exclude from her diet sugar and foods containing sugar.

_____ True _____ False

12. Assume Lois will attempt to consume 2,000 calories a day. Based on that level of calorie intake, her fiber intake should total approximately 28 g daily.

_____ True _____ False

13. Lois plans to perform aerobic exercise 25 minutes daily because it will help improve insulin resistance, lower blood glucose levels, and improve her blood lipid levels.

_____ True _____ False

14. Lois should take a chromium supplement to help lower her blood glucose levels.

_____ True _____ False

15. Poorly controlled blood glucose levels before pregnancy are a risk factor for congenital malformation in newborns.

_____ True _____ False

16. Weight loss, healthy dietary patterns, and exercise prior to pregnancy are related to a reduced risk of gestational diabetes.

_____ True _____ False

17. Weight loss of 7 percent of body weight and exercise reduce the risk of type 2 diabetes.

_____ True _____ False

18. Excess visceral fat and insulin resistance are shared characteristics among women with PCOS.

_____ True _____ False

19. Weight loss and exercise improve insulin sensitivity and insulin levels, and lower fasting glucose and testosterone levels in women with PCOS.

_____ True _____ False

20. Infants born to women with high blood levels of phenylalanine during pregnancy are at elevated risk of seizures, intellectual disability, and abnormal behavioral patterns.

_____ True _____ False

21. Individuals with PKU can safely consume high-protein foods such as beef, chicken, or eggs once a day.

_____ True _____ False

22. Individuals born with PKU who adhere to an adequate, low-phenylalanine diet during childhood and later in life tend to develop normally or at levels that are somewhat below normal.

_____ True _____ False

23. Individuals with celiac disease have overt symptoms that are easily identified. Consequently, the existence of celiac disease tends to be strongly suspected in cases of infertility.

_____ True _____ False

24. Individuals with active celiac disease share the problems of abdominal pain, headache, nutrient malabsorption, and iron deficiency.

_____ True _____ False

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4

Nutrition During Pregnancy

Prepared by Judith E. Brown with Ellen Lechtenberg

Learning Objectives

After studying the materials in this chapter, you should be able to:

4.1 Identify three problem areas related to pregnancy outcomes in the United States.

4.2 Describe five physiological changes that normally occur during pregnancy that would be considered abnormal if they did not occur during pregnancy.

4.3 Correlate critical periods of growth and development and the potential consequences of inadequate energy and nutrient availability during these periods on future health status.

4.4 Identify recommended weight gain ranges for women who enter pregnancy underweight, normal weight, overweight, and obese.

4.5 Correlate three examples of relationships between nutritional status during pregnancy and long-term health outcomes in offspring.

4.6 Provide five examples of how the need for energy and specific nutrients change due to pregnancy.

4.7 Identify three factors that influence dietary intake during pregnancy that are not related to food availability.

4.8 Develop a one-day diet for pregnancy based on MyPlate.gov food intake recommendations for pregnancy.

4.9 Describe two reasons why pregnant women and their fetuses are particularly vulnerable to certain foodborne illnesses.

4.10 Identify the basic components of a nutritional assessment of pregnant women.

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4.11 Identify three health benefits to women of regular exercise during pregnancy.

4.12 Assess three common health problems during pregnancy and the evidence on the effectiveness of dietary interventions for their treatment or amelioration.

4.13 Describe the nutrition service components of a model nutrition program during pregnancy.

Introduction

On average, Americans have worse health outcomes than their counterparts in other high-income countries, even though the United States spends far more on health care than other countries do.

The 9 months of pregnancy represent the most intense period of growth and development humans ever experience. How well these processes go depends on many factors, most of which are modifiable. Of the factors affecting fetal growth and development that are within our control to change, nutritional status stands out. At no other time in life are the benefits of optimal nutritional status more obvious than during pregnancy.

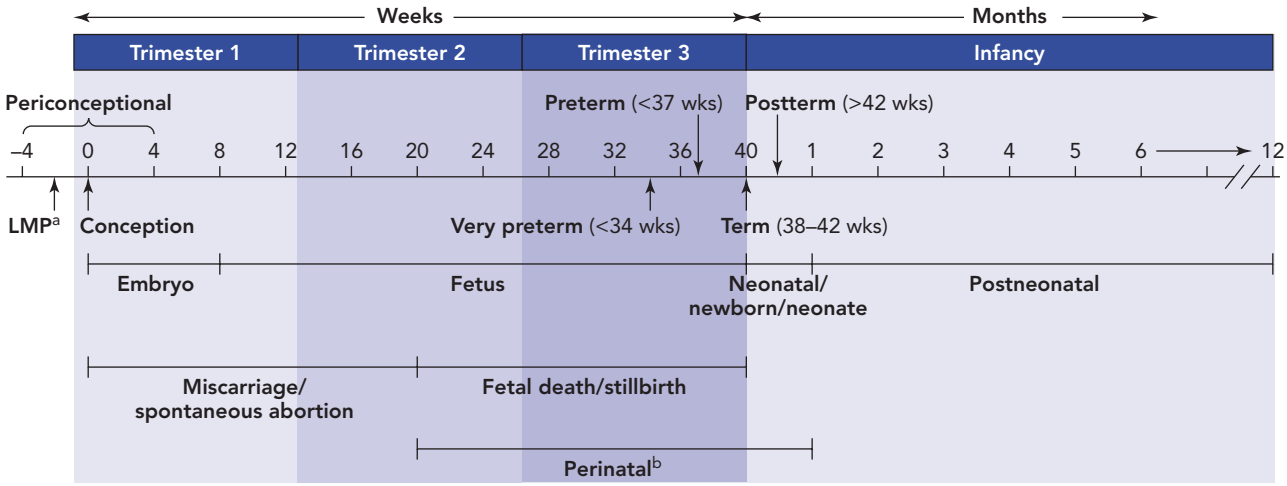
This chapter addresses the status of pregnancy outcomes in the United States and other countries. It covers physiological changes that take place to accommodate pregnancy, and the impact of these changes on maternal nutritional needs. The chapter presents the roles of nutrition in fostering fetal growth, development, and long-term health; it also covers dietary supplement use and weight-gain recommendations. The discussion goes on to consider common problems during pregnancy that can be addressed with nutritional remedies. Chapter 5 addresses clinical conditions and nutrition interventions during pregnancy. We begin this chapter by highlighting vital statistics reports that clearly show a need for improving pregnancy outcomes in the United States.

4.1 The Status of Pregnancy Outcomes

The status of reproductive outcomes in the United States and other economically developed countries is routinely assessed through examination of a particular set of vital statistics; data called *natality* statistics (*natality* means "related to birth"). Natality statistics summarize important information about the occurrence of pregnancy complications and harmful behaviors, in addition to infant mortality (death) and morbidity (illness) rates within a specific population. Figure 4.1 presents a time line of key intervals and events before, during, and after pregnancy. Table 4.1 provides natality statistics for the periods and outcomes shown in Figure 4.1.[1-4] These data are used to identify problems in need of resolution and to identify progress in meeting national goals for improvement in the course and outcome of pregnancy. (Note: A table of measurement abbreviations and equivalents is located in Appendix A.)

Infant Mortality

Infant mortality reflects the general health and socioeconomic status of a population. The reason for this is because so many of the socioeconomic and environmental factors that influence the health of females who are pregnant and newborns also affect the health of the rest of the population (Figure 4.2).[5] This historical view of infant mortality rates



[a] LMP = last menstrual period
[b] Perinatal definition varies from 20 to 24 weeks' gestation to 7 to 28 days after birth.

Figure 4.1 Time-related terms before, during, and after pregnancy.

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Table 4.1 Natality statistics: rates, definitions, and trends in the United States[1-4]

	Rates			
	1995	**2014–2016**	**2019–2021**	**Definition**
Maternal mortality	7.1	28	33	Deaths/100,000 live births
Fetal deaths (stillbirths)	7.0	6.1	5.7	Deaths/1,000 pregnancies over 20 weeks gestation
Perinatal mortality	7.6	6.3	5.7	Deaths/1,000 deliveries over 20 weeks gestation to 7 days after birth
Neonatal mortality	4.9	4.0	3.7	Deaths from delivery to 28 days/1,000 live births
Postneonatal mortality	2.7	2.2	1.96	Deaths from 28 days after birth to 1 year/1,000 live births
Infant mortality	7.6	5.8	5.6	Deaths from birth to age 1 year/1,000 live births
Preterm	11.0	9.9	10.5	Births < 37 weeks, gestation/100 live births
Very preterm	1.9	3.5	2.8	Births < 34 weeks, gestation/100 live births
Low birthweight	7.3	8.2	8.5	Newborn weights < 2,500 g (5 lb 8 oz)/100 live births
Very low birthweight	1.4	1.4	1.4	Newborn weights < 1,500 g (3 lb 4 oz)/100 live births
Multifetal pregnancies				
Twins	1 in 40	1 in 34	1 in 32 (31.2/1,000)	Number of twin births/total live births
Triplets +	1 in 784	1 in 652	1 in 1,250 (80/100,000)	Number of triplets plus higher-order multiple births/total live births
Adolescent pregnancies	56.8	20.3		Births/1,000 women aged 15–19 years

indicates that population-wide improvements in social circumstances, infectious disease control, and availability of safe and nutritious foods have corresponded to greater reductions in infant mortality than have technological advances in medical care.[1,2,6] Small improvements in infant mortality in the past few decades in the United States are largely due to technological advances in and access to health care. Currently, the infant mortality rate for the United States is 5.6 per 1,000 live births. Even though the United States spends more money on health care than any other nation, the infant mortality rate ranks 50th among countries of the world (Figure 4.3), and maternal mortality is 76 percent higher than other wealthy nations.[1,7–10]

liveborn infant A liveborn infant is the outcome of delivery when a completely expelled or extracted fetus breathes, or shows any sign of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the cord has been cut or the placenta is still attached.

A standard definition of a **liveborn infant** is implemented internationally to identify infant live births. It is unlikely that

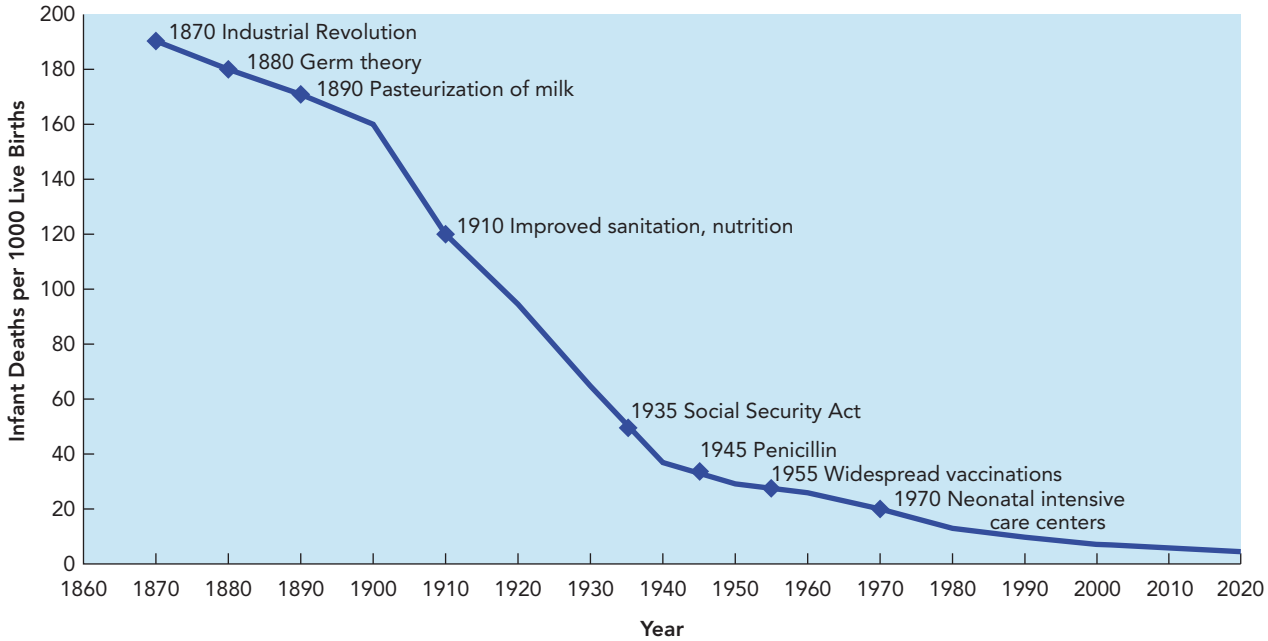


Figure 4.2 Chronology of events related to declines in infant mortality in the United States.
Source: Judith E. Brown, 2003–2020.

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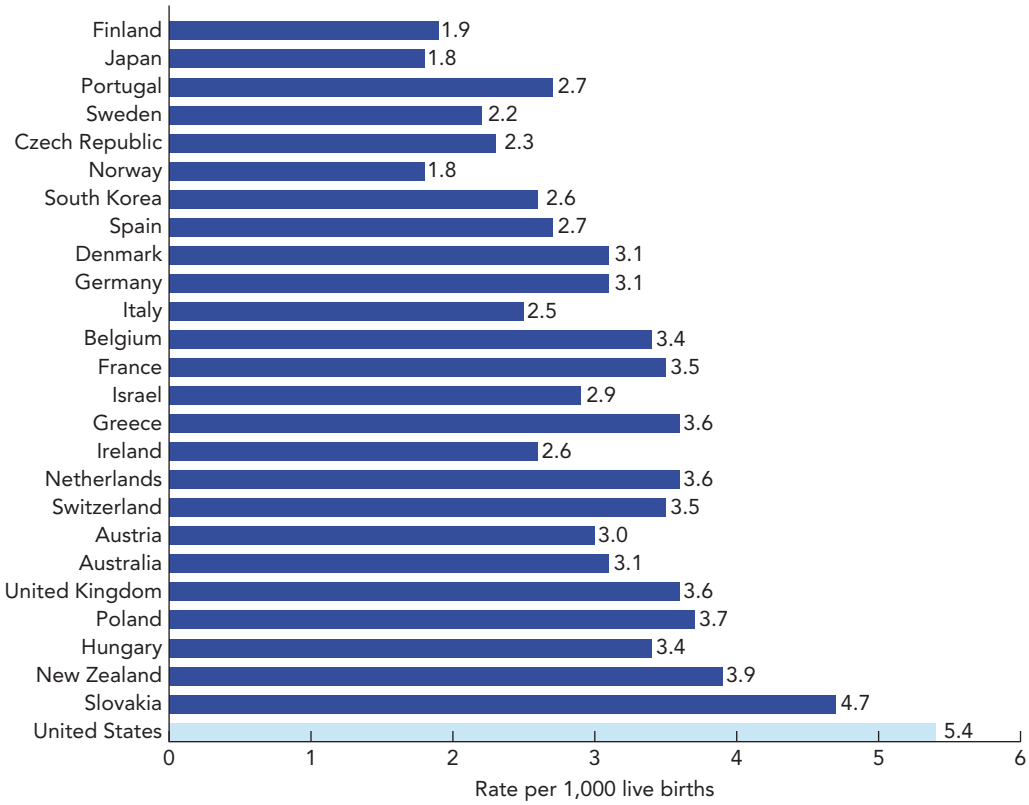


Figure 4.3 Infant mortality rates by country 2023.
Illustration shows a graph of infant mortality rate by country.
Source: Data from Infant Mortality Rate by Country 2023. Available at worldpopulationreview.com, accessed February 12, 2023.

differences in the definition or reporting of infant mortality among countries account for the relatively high ranking of the United States.[8] Two-thirds of deaths of liveborn infants occur within the first month after birth, the neonatal period.

Low Birthweight, Preterm Delivery, and Infant Mortality

Infants born at low birthweight or preterm are at a substantially higher risk of dying in the first year of life than are larger and older newborns. Low-birthweight infants make up about 8.5 percent of all births, yet comprise 16 percent of all infant deaths. The 10.5 percent of newborns delivered prior to 37 weeks of pregnancy similarly account for a disproportionately large number of infant deaths.[1,5,12] Low-birthweight and preterm infant outcomes are intertwined in that the shorter the pregnancy, the less newborns tend to weigh (Table 4.2).

Rates of preterm delivery and low birthweight in the United States have trended slowly downward in the last decade but remain higher in African American infants than in other infants (Table 4.3).[1] The relatively high rates of preterm and low birthweight in African American infants clearly represents a health disparity in need of resolution. Racial discrimination, poor access to nutritious foods, lack of access to health care, and poverty appear to account for a portion of the differences in infant mortality among African Americans in the United States[1,2,12]

Table 4.2 U.S. range of birthweights by gestational age[1,2,11,12]

Birthweight		Weeks' Gestation	Infant Mortality Rate
Pounds (lb) and Ounces (oz)	Grams		
<1 lb 2 oz	<500	20–23	584.8
1 lb 2 oz–1 lb 10 oz	500–749	24–27	210.8
1 lb 10 oz–2 lb 3 oz	750-999	24–27	121.0
2 lb 3 oz–2 lb 12 oz	1,000–1,249	28–31	76.2
2 lb 12 oz–3 lb 3 oz	1,250–1,499	28–31	55.3
3 lb 3 oz–4 lb 6 oz	1,500–1,999	31–32	27.6
4 lb 6 oz–5 lb 8 oz	2,000–2,499	32–33	8.2
5 lb 8 oz–6 lb 10 oz	2,500–2,999	34–36	2.2
6 lb 10 oz–7 lb 11 oz	3,000–3,499	37–38	0.8
7 lb 11 oz–8 lb 13 oz	3,500–3,999	39–40+	0.6
8 lb 13 oz–9 lb 14 oz	4,000–4,499	40+	1.2

Reducing Infant Mortality and Morbidity

Deaths and illnesses associated with low-birthweight and preterm infants can be reduced to an important extent through improvements in the birthweight of newborns. Infants weighing 3,500 to 4,500 g at birth (or 7 lb 12 oz to 10 lb) are least likely to die within the first year of life,

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Table 4.3 Rates of preterm delivery and low birthweight for the U.S. population and by ethnic/racial background, 2019[1,12]

	Preterm	Low Birthweight
All	10.5	8.5
Non-Hispanic Blacks	14.75	14.66
Non-Hispanic Whites	9.5	7.18
American Indian/Alaskan Native	12.26	8.11
Asian/Pacific Islander	12.69	9.14
Hispanic	9.23	6.9

Table 4.4 2030 health objectives for the nation related to pregnant women and infants[6]

• Reduce severe maternal complications identified during delivery hospitalizations-MICH-05
• Reduce the rate of fetal deaths at 20 or more weeks of gestation-MICH-01
• Increase the proportion of women who get screened for postpartum depression-MICH-DO1
• Increase abstinence from illicit drugs among pregnant women-MICH-11
• Reduce the proportion of unintended pregnancies-FP-01
• Reduce preterm births-MICH-07
• Increase abstinence from alcohol among pregnant women-MICH-09
• Increase the proportion of women who had a healthy weight before pregnancy-MICH-13
• Increase the proportion of pregnant women who receive early and adequate prenatal care-MICH-08
• Reduce the proportion of women who use illicit opioids during pregnancy-MICH-DO2
• Reduce the proportion of pregnancies conceived within 18 months of previous birth-FP-02
• Reduce pregnancies in adolescents-FP-03
• Increase the proportion of women at risk for unintended pregnancy who use effective birth control -FP-10
• Increase the proportion of adolescents of females at risk for unintended pregnancy who use effective birth control-FP-11
• Reduce congenital syphilis -STI-04
• Reduce the rate of mother-to-child HIV transmission-HIV-06 I
• Increase abstinence from cigarette smoking among pregnant women-MICH-10
• Increase successful quit attempts in pregnant women who smoke-TU-15
• Increase the proportion of women who get a Tdap vaccine during pregnancy-IID-DO1
• Reduce caesarean births among low-risk women with no prior briths-MICH-06
• Reduce maternal deaths-MICH-04
• Increase the proportion of women of childbearing age who get enough folic acid-MICH-12

as well as in the perinatal, neonatal, and postneonatal periods[13] Newborns weighing 3,500 to 4,500 g are also at an advantage as a group in relation to overall health status and subsequent mental development.[14,15] They are less likely to develop heart disease, diabetes, lung disease, hypertension, and other disorders later in life.[16] Reducing the proportion of infants born small, early, or both would clearly decrease infant mortality.

2030 Health Objectives for the Nation National health objectives for pregnancy and childbirth focuses on preventing pregnancy complications and maternal deaths and helping women stay healthy before, during, and after pregnancy. A number of the objectives are listed in Table 4.4. U.S. public health efforts are also being targeted at improving prenatal weight gain, access to care, and behaviors that adversely affect the course and outcome of pregnancy in all population groups.

4.2 Physiology of Pregnancy

Conception triggers thousands of complex and sequenced biological changes that transform two united cells into a member of the next generation of human beings. The rapidity with which metabolic and functional changes occur within the mother, uterus, placenta, embryo, and fetus places high demands on maternal nutrient reserves available at conception. How well these processes proceed have both short- and long-term effects on health, growth, development, and disease risk throughout life.[17]

Pregnancy begins at conception; that occurs approximately 14 days before the next menstrual period is scheduled to begin and ovulation occurs. Assessed from conception, pregnancy averages 38 weeks, or 266 days, in length. Most commonly, however, pregnancy duration is given as 40 weeks (280 days) because it is measured from the date of the first day of the last menstrual period (LMP). Consequently, the common way of measuring pregnancy duration includes two nonpregnant weeks at the beginning. The anticipated date of delivery is denoted by the ancient terminology of *estimated date of confinement*, or EDC. Maternal circulating nutrients, some of which are drawn from maternal nutrient stores, are utilized to support plasma volume expansion and the physiological processes that follow.

Maternal Physiology

Changes in maternal physiology during pregnancy are so profound that they were previously considered abnormal and in need of correction. Doctors routinely advised pregnant women to follow low-sodium diets to reduce fluid retention, restricted their patients' weight gain and dietary intake to prevent complications at delivery, and prescribed excessive levels of iron and other supplements to bring blood nutrient levels back up to "normal." We now know that what is considered normal physiological status

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Table 4.5 Sequence of tissue development and approximate gestational week of maximal rates of change in maternal systems, the placenta, and fetus during pregnancy[19]

Tissue	Sequence of Development	Gestational Week of Maximal Rate of Growth
Maternal plasma volume	1	20
Maternal nutrient stores	2	20
Placental weight	3	31
Uterine blood flow	4	37
Fetal weight	5	37

of nonpregnant women cannot be considered normal for women who are pregnant. Fortunately, it is now understood that attempts to bring maternal physiological changes back to nonpregnant levels may cause more harm than good to the pregnancy.

Changes in maternal body composition and functions occur in a specific sequence during pregnancy. The order of the sequence is absolute because the successful completion of each change depends on the one before it. Because maternal nutritional status and physiological changes set the stage for fetal growth and development, they begin in earnest at conception.[16,17]

The sequence of physiological changes taking place during pregnancy is listed in Table 4.5. To provide the fetus with sufficient energy, nutrients, and oxygen for growth, the mother must first expand the volume of plasma that can be circulated. Duration of pregnancy varies somewhat based on maternal parity and age. It tends to be several days shorter for parous women and those older than 35 years. Similarly, the maximal rate of placental growth is timed to precede that of fetal weight gain. This sequence of events ensures that the **placenta** is fully prepared for the high level of functioning that will be needed as fetal weight increases most rapidly. Fetuses depend on the functioning of multiple systems, established well in advance of their maximal rates of growth and development. Abnormalities in the development of any of these physiological systems can modify subsequent fetal growth and development.

Normal Physiological Changes During Pregnancy

The list of physiological changes that normally occur during pregnancy is extensive (Table 4.6), and such changes affect every maternal organ and system. Changes that are most directly related to maternal energy and nutrient needs are discussed here.

placenta A disk-shaped organ of nutrient and gas interchange between mother and fetus. At term, the placenta weighs about 15 percent of the weight of the fetus.

Table 4.6 Normal changes in maternal physiology during pregnancy[17,18]

Blood Volume Expansion
- Blood volume increases 20%
- Plasma volume increases 50%
- Edema (occurs in 60–75% of women)

Hemodilution
- Concentrations of many vitamins and minerals in blood decrease

Blood Lipid Levels
- Increased concentrations of cholesterol, LDL cholesterol, triglycerides, HDL cholesterol

Blood Glucose Levels
- Increased insulin resistance (increased plasma levels of glucose and insulin)

Maternal Organ and Tissue Enlargement
- Heart, thyroid, liver, kidneys, uterus, breasts, adipose tissue

Circulatory System
- Increased cardiac output through increased heart rate and stroke volume (30–50%)
- Increased heart rate (16% or 6 beats/min)
- Decreased blood pressure in the first half of pregnancy (29%), followed by a return to nonpregnancy levels in the second half

Respiratory System
- Increased tidal volume, or the amount of air inhaled and exhaled (30–40%)
- Increased oxygen consumption (10%)

Food Intake
- Increased appetite and food intake; weight gain
- Taste and odor changes, modification in preference for some foods
- Increased thirst

Gastrointestinal Changes
- Relaxed gastrointestinal tract muscle tone
- Increased gastric and intestinal transit time
- Nausea (70%), vomiting (40%)
- Heartburn
- Constipation

Kidney Changes
- Increased glomerular filtration rate (50–60%)
- Increased sodium conservation
- Increased nutrient spillage into urine; protein is conserved
- Increased risk of urinary tract infection

Immune System
- Suppressed immunity
- Increased risk of urinary, reproductive tract, and other infections

Basal Metabolism
- Increased basal metabolic rate in second half of pregnancy
- Increased body temperature

Hormones
- Placental secretions of large amounts of hormones needed to support physiological changes of pregnancy

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Body Water Changes A woman's body gains a good deal of water during pregnancy, primarily due to increased volumes of plasma and extracellular fluid, as well as amniotic fluid. The primary purpose of increased body water composition is to expand blood flow and nutrient transfer to the placenta and fetus.[19,20] Total body water increases in pregnancy range from 7 to 10 L (approximately 7 to 10 quarts, or about 2 to 2½ gallons). About two-thirds of the expansion is intracellular (blood and body tissues) and one-third is extracellular (fluid in spaces between cells).[21] Plasma volume begins to increase within a few weeks after conception and reaches a maximum at approximately 34 weeks. Early pregnancy surges in plasma volume appear to be the primary reason that pregnant women feel tired and become exhausted easily when undertaking exercise performed routinely prior to pregnancy. Fatigue associated with plasma-volume increases in the second and third months of pregnancy declines as other compensatory physiological adjustments are made.

Gains in body water vary a good deal among women during normal pregnancy. High gains are associated with increasing degrees of **edema** and weight gain. If not accompanied by hypertension, edema generally reflects a healthy expansion of plasma volume. Birthweight is strongly related to plasma volume; generally, the greater the expansion, the greater the newborn size. The increased volume of water in the blood is responsible for the "dilution effect" of pregnancy on blood concentrations of some vitamins and minerals. Blood levels of fat-soluble vitamins tend to increase in pregnancy, whereas levels of the water-soluble vitamins tend to decrease. Vitamin supplement use can modify these relationships.[21–23]

Hormonal Changes Many of the normal physiological changes that occur during pregnancy are modulated by hormones produced by the placenta (Figure 4.4). The placenta serves many roles (they are presented later in this chapter), but a key one is the production of **steroid hormones**, such as progesterone and estrogen. The placenta is also the main supplier of many other hormones needed to support the physiological changes of pregnancy (Table 4.7).

Maternal Nutrient Metabolism Adjustments in maternal nutrient metabolism are apparent within the first few weeks after conception and progress throughout pregnancy.[12] Many of the adjustments are directed toward ensuring that nutrients will be available to the fetus during periods of high nutrient needs. The amount and types of nutrients required depend on what is needed for specific metabolic pathways to function and for fetal structures to develop. Because normal fetal tissue growth and development are genetically timed, nutrients must be available at the same time that genes controlling fetal growth and development are expressed.[16,23,24]

edema Swelling (usually of the legs and feet, but can also extend throughout the body) due to an accumulation of extracellular fluid.

steroid hormones Hormones such as progesterone, estrogen, and testosterone produced primarily from cholesterol.

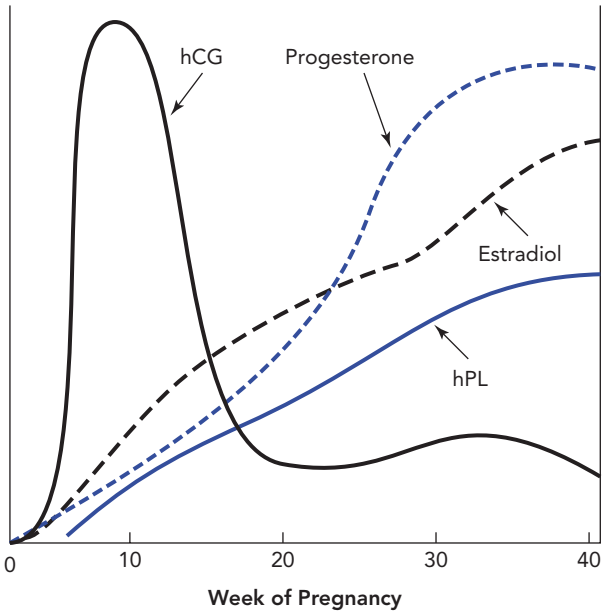


Figure 4.4 Patterns of changes in maternal plasma levels of hormones during pregnancy.
Source: Graph sketched by J. E. Brown.

Carbohydrate Metabolism Many adjustments in carbohydrate metabolism are made during pregnancy that promote the availability of glucose to the fetus. Glucose is

Table 4.7 Key placental hormones and examples of their roles in pregnancy[20,21]

Human chorionic gonadotropin (hCG)
Maintains early pregnancy by stimulating the corpus luteum to produce estrogen and progesterone. It stimulates growth of the endometrium. The placenta produces estrogen and progesterone after the first 2 months of pregnancy.
Progesterone
Maintains the implant; stimulates growth of the endometrium and its secretion of nutrients; relaxes smooth muscles of the uterine blood vessels and gastrointestinal tract; stimulates breast development; promotes lipid deposition.
Estrogen
Increases lipid formation and storage, protein synthesis, and uterine blood flow; prompts uterine and breast duct development; promotes ligament flexibility.
Human chorionic somatotropin (hCS)
Increases maternal insulin resistance to maintain glucose availability for fetal use; promotes protein synthesis and the breakdown of fat for energy for maternal use.
Human placental lactogen
Supports fetal growth and development by triggering metabolic changes that increase the availability of glucose and amino acids.
Leptin
May participate in the regulation of appetite and lipid metabolism, weight gain, and utilization of fat stores.

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the fetus' preferred fuel, even though fats can be utilized for energy. Continued availability of a fetal supply of glucose is accomplished primarily through metabolic changes that promote maternal insulin resistance. These changes, sometimes referred to as the *diabetogenic effect of pregnancy*, make normal pregnant women slightly carbohydrate intolerant in the third trimester of pregnancy (Figure 4.5).[25]

Carbohydrate metabolism in the first half of pregnancy is characterized by estrogen- and progesterone-stimulated increases in insulin production and conversion of glucose to glycogen and fat. In the second half, rising levels of hCS and prolactin from the mother's pituitary gland inhibit the conversion of glucose to glycogen and fat. At the same time, insulin resistance builds in the mother, increasing her reliance on fats for energy. Decreased conversion of glucose to glycogen and fat, lowered maternal utilization of glucose, and increased liver production of glucose help to ensure that a constant supply of glucose for fetal growth and development is available in the second half of pregnancy.[25]

Fasting maternal blood glucose levels decline in the third trimester due to increased utilization of glucose by the rapidly growing fetus. However, post-meal blood glucose concentrations are elevated and remain higher longer than before pregnancy.[25]

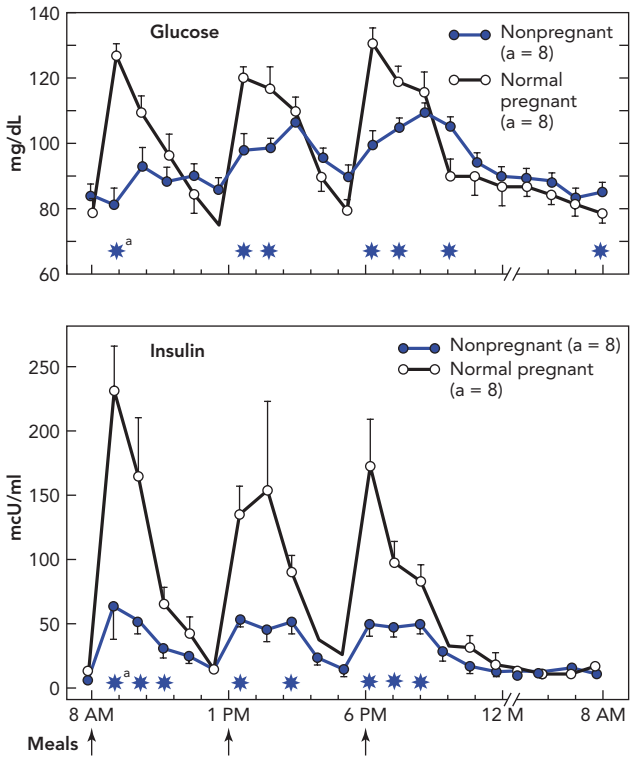


Figure 4.5 Plasma glucose and insulin levels in nonpregnant women and in women near term.

Sources: Reprinted from *Am J Obstet and Gynecol.* 1981; 140(6): 730–736. Phelps, R. L., et al., © 1981, with permission from Elsevier; a * indicates statistical significance; Wolever,T. M., Mehling, C. Long-term effect of varying the source or amount of dietary carbohydrate on postprandial plasma glucose, insulin, triacylglycerol, and free fatty acid concentrations in subjects with impaired glucose tolerance. *Amer J of Clin Nutr.* 2003 Mar 1; 77(3):612–621.

Accelerated Fasting Metabolism Maternal metabolism is rapidly converted toward **glucogenic amino acid** utilization, fat oxidation, and increased production of **ketones** with fasts that last longer than 12 hours. Decreased levels of plasma glucose and insulin and increased levels of triglycerides, free fatty acids, and ketones are seen hours before they occur in nonpregnant fasting women. The rapid conversion to fasting metabolism allows pregnant women to use primarily stored fat for energy while sparing glucose and amino acids for fetal use.[26]

Although these metabolic adaptations help ensure a constant fetal supply of glucose, fasting eventually increases the dependence of the fetus on ketone bodies for energy. Prolonged fetal utilization of ketones, such as occurs in women with poorly controlled diabetes or in those who lose weight during part or all of pregnancy, is associated with abnormal growth and impaired intellectual development of the offspring.[26,27]

Protein Metabolism Nitrogen and protein are needed in increased amounts during pregnancy for synthesis of new maternal and fetal tissues. It is estimated that 925 g (2 lb) of protein are accumulated during pregnancy.[19] To some extent, the increased need for protein is met through reduced levels of nitrogen excretion and the conservation of amino acids for protein tissue synthesis. There is no evidence, however, that the mother's body stores protein early in pregnancy in order to meet fetal needs for protein later in pregnancy. Maternal and fetal needs for protein are primarily fulfilled by the mother's intake of protein during pregnancy.[17]

Fat Metabolism Multiple changes occur in the body's utilization of fats during pregnancy. Overall, changes in lipid metabolism promote the accumulation of maternal fat stores in the first half of pregnancy and enhance fat mobilization in the second half.[28] Increased fat mobilization causes blood lipid levels to increase dramatically (Table 4.8). Plasma triglyceride levels increase first, more than doubling nonpregnant levels by term.[29] Cholesterol-containing

Table 4.8 Approximate changes in cholesterol and triglyceride levels during normal pregnancy[29,33]

Trimester	Cholesterol mmol/L	(mg/dL)	Triglycerides mmol/L	(mg/dL)
1	4.53	(175)	1.19	(105)
2	5.18	(200)	1.32	(117)
3	6.22	(240)	2.58	(228)
Nonpregnant	4.27	(165)	1.05	(93)

glucogenic amino acids Amino acids such as alanine and glutamate that can be converted to glucose.

ketones Metabolic by-products of the breakdown of fatty acids in energy formation. β-hydroxybutyric acid, acetoacetic acid, and acetone are the major ketones, or *ketone bodies.*

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lipoproteins, phospholipids, and fatty acids also increase, but to a lesser extent than do triglycerides. The increased cholesterol supply is used by the placenta for steroid hormone synthesis, and by the fetus for nerve and cell membrane formation.[26]

High concentrations of cholesterol and triglycerides observed during normal pregnancy have not been found to promote the development of atherosclerosis (hardening of the arteries).[30] However, evidence suggests that abnormally high levels of cholesterol and triglycerides may indicate the prepregnancy existence of insulin resistance or another disorder. Insulin resistance before conception increases the risk that diabetes and hypertension will develop during pregnancy.[25,31,32]

By the third trimester of pregnancy, most women have a lipid profile that would be considered atherogenic if not for pregnancy. Although a cholesterol-lowering diet during pregnancy has been found to lower maternal cholesterol levels somewhat, it does not appear to alter cord and neonatal cholesterol levels.[17] Increases in HDL cholesterol in pregnancy as well as other changes in serum lipids appear to revert to prepregnancy levels postpartum.[33]

Mineral Metabolism Impressive changes in maternal mineral metabolism occur during pregnancy in order to support plasma volume expansion and the transfer of minerals to the growing fetus. To provide the fetus with calcium needed for bone formation, maternal absorption of calcium and the rate of calcium mobilization from bones increase.[34]

Elevated levels of body water and tissue synthesis during pregnancy are accompanied by increased requirements for sodium and other minerals. Sodium metabolism is delicately balanced during pregnancy to promote an accumulation of sodium by the mother, placenta, and fetus. This is accomplished by changes in the kidneys that increase aldosterone secretion and the retention of sodium. Low-salt or low-sodium diets are not recommended during pregnancy because they may be harmful and have not been shown to reduce the risk of hypertension.[35] Sodium restriction may overstress mechanisms that act to conserve sodium and lead to functional and growth impairments due to sodium depletion.[36]

The Placenta

The word *placenta* is derived from the Latin word for "cake." The placenta, with its round, disk-like shape (Photo 4.1), looks somewhat like a cake—with some imagination. The placenta develops from embryonic tissue and is larger than the fetus for most of pregnancy. Development of the placenta precedes fetal development.

Functions of the placenta include the following:

- Hormone and enzyme production
- Nutrient and gas exchange between the mother and fetus
- Removal of waste products from the fetus[37]



Southern Illinois University/Science Source

Photo 4.1 A placenta.

Its structure, including three to four layers of cells separating maternal and fetal blood, acts as a barrier to many harmful compounds, and it governs the rate of passage of nutrients and other substances into and out of the fetal circulation (Figure 4.6). The barrier role of the placenta is better described as a fence than as a filter that guards the fetus against all things harmful. Many potentially harmful substances (alcohol, excessive levels of some vitamins, drugs, and certain bacteria such as listeria, for example) do pass through the placenta to the fetus.[38] The placenta is a barrier to the passage of many types of bacteria and viruses, maternal red blood cells, and large proteins. The placenta prevents the mixing of fetal and maternal blood until delivery, when ruptures in blood vessels may occur.[39]

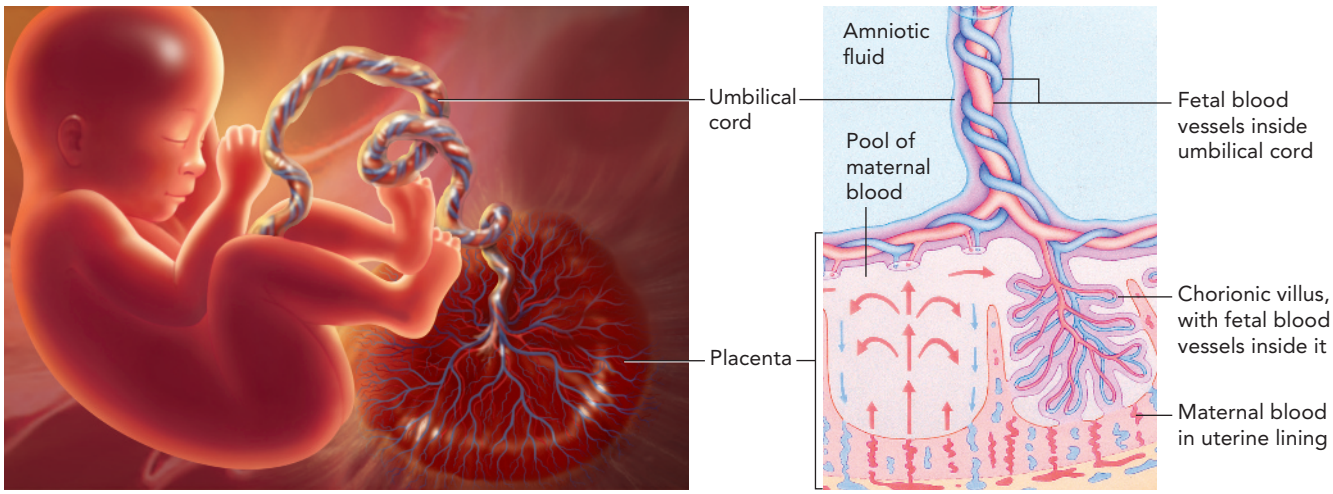
Nutrient Transfer The placenta uses 30–40 percent of the glucose delivered by the maternal circulation. If nutrient supply is low, the placenta fulfills its own needs before nutrients are made available to the fetus. If nutrient supplies fall short of meeting placental needs, functioning of the placenta is compromised to sustain the nutrient supply and health of the mother.[17]

Nutrient transfer across the placenta depends on a number of factors, including:

- The size and the charge of molecules available for transport
- Lipid solubility of the particles being transported
- The concentration of nutrients in maternal and fetal blood

Small molecules with little or no charge (water, for example) and lipids (cholesterol and ketones, for instance) pass through the placenta most easily, while large molecules (e.g., insulin and enzymes) aren't transferred at all.

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Artist's depiction of the view inside the uterus, showing a fetus connected by an umbilical cord to the pancake-shaped placenta.

The placenta consists of maternal and fetal tissue. Fetal blood flowing in vessels of chorionic villi exchanges substances by diffusion with maternal blood around the villi. The bloodstreams do not mix.

Figure 4.6 Structure of the placenta. Maternal arteries and veins are part of the maternal circulation, whereas umbilical arteries and veins are part of the fetal circulation. Blood enters the fetus through umbilical veins and exits through umbilical arteries.

Source: Starr, C., Evers, C., & Starr, L. *Biology: The Unity and Diversity of Life*, 14th ed., Cengage Learning, Boston, MA, 2016.

Nutrient exchange between the mother and fetus is unregulated for some nutrients, oxygen, and carbon dioxide; it is highly regulated for other nutrients. Nutrient transfer based on concentration gradients determined by the levels of the nutrient in the maternal and the fetal blood is unregulated. In these cases, nutrients cross placenta membranes by simple diffusion from blood with high concentration of the nutrient to blood with lower concentration. Three primary mechanisms regulate nutrient transfer: facilitated diffusion, active transport, and endocytosis (or pinocytosis) (Table 4.9).

The fetus receives small amounts of water and other nutrients from ingestion of **amniotic fluid**. By the second half of pregnancy, the fetus is able to swallow and absorb water, minerals, nitrogenous waste products, and other substances in amniotic fluid.[40]

The Fetus Is Not a Parasite Contrary to popular wisdom, the fetus cannot take whatever nutrients it needs from the mother's body at the mother's expense. When maternal nutrient intakes fall below optimum levels or adjustment thresholds, fetal growth and development are compromised more than maternal health.[17] In general, nutrients will first

amniotic fluid The fluid contained in the amniotic sac that surrounds the fetus in the uterus.

Table 4.9 Mechanisms of nutrient transport across the placenta[22,37]

Mechanism	Examples of Nutrients
Passive diffusion (also called *simple diffusion*) Nutrients transferred from blood with higher concentration levels to blood with lower concentration levels	Water, some amino acids and glucose, free fatty acids, ketones, vitamins E and K,[a] some minerals (sodium, chloride), gases
Facilitated diffusion Receptors ("carriers") on cell membranes increase the rate of nutrient transfer	Some glucose, iron, vitamins A and D
Active transport Energy (from ATP) and cell membrane receptors	Water-soluble vitamins, some minerals (calcium, zinc, iron, potassium) and amino acids
Endocytosis (also called *pinocytosis*) Nutrients and other molecules are engulfed by placenta membrane and released into fetal blood supply	Immunoglobulins, albumin

[a] Vitamin K crosses the placenta slowly and to a limited degree.

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be used to support maternal nutrient needs for her health and physiological changes, and next for placental development, before they become available at optimal levels to the fetus. For example:

- Women who are underweight that gain the same amount of weight as women within a normal weight range tend to deliver smaller infants and retain more of the weight gained during pregnancy at the expense of fetal growth.[22]
- Fetal growth tends to be reduced in teenagers who are pregnant and gain height during pregnancy compared to fetal growth in teens who do not grow during pregnancy.[41]

growth Increase in an organism's size through cell multiplication (hyperplasia) and enlargement of cell size (hypertrophy).

development Progression of the physical and mental capabilities of an organism through growth and differentiation of organs and tissues, and integration of functions.

differentiation Cellular acquisition of one or more characteristics or functions different from that of the original cells.

critical periods Pre-programmed time periods during embryonic and fetal development when specific cells, organs, and tissues are formed and integrated, or functional levels established. Also called *sensitive periods*.

- Vitamin and mineral deficiencies and toxicities in newborns have been observed in women who showed no signs of deficiency or toxicity diseases during pregnancy.[42]

If the fetus did act as a parasite, it would harm the mother for its own benefit. Rather, the fetus is generally harmed more by poor maternal nutritional status than the mother.[22]

4.3 Embryonic and Fetal Growth and Development

The rate of human **growth** and **development** is higher during gestation than at any time thereafter (Table 4.10). If the rate of weight gain achieved in the 9 months of gestation continued after delivery, infants would weigh about 160 pounds at their first birthdays and be 20 ft tall by age 20!

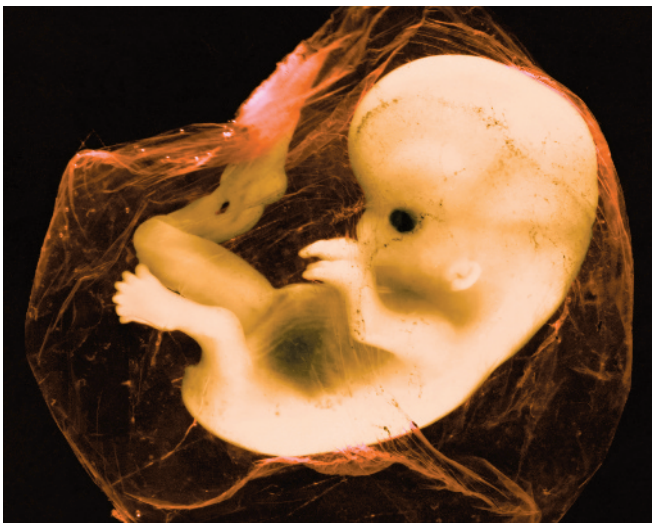
Critical Periods of Growth and Development

Fetal growth and development proceed along genetically determined pathways in which cells are programmed to multiply, **differentiate**, and establish long-term functional levels during set time intervals. Such time intervals, known as **critical periods,** are most intense during the first 2 months after conception, when a majority of organs and tissues begin to form (Photo 4.2). On the whole, critical periods represent a "one-way street" because it is not possible to reverse directions and correct errors in growth or development that occurred during a previous critical period. Consequently, adverse effects of nutritional and

Table 4.10 Notes on normal embryonic and fetal growth and development[17,21,22]

Day 1	Conception; one cell, called the zygote, exists.	**Week 9**	Embryo now considered a fetus.
Day 2–3	Eight cells have formed (called the morula) and enter the uterine cavity.	**Month 3**	Weighs 1 oz; primitive egg and sperm cells developed, hard palate fuses, breathes in amniotic fluid.
Day 6–8	The morula becomes fluid-filled and is renamed the blastocyst. The blastocyst is comprised of 250 cells, and cell differentiation begins.	**Month 4**	Weighs about 6 oz; placenta diameter is 3 in.
Day 10	Embryo implants into the uterine wall, where glycogen is accumulating.	**Month 5**	Weighs about 1 lb, 11 in. long; skeleton begins to calcify, hair grows.
Day 12	Embryo is composed of thousands of cells; differentiation well under way. Utero placental circulation being formed.	**Month 6**	14 in. long; fat accumulation begins, permanent teeth buds form; lungs, gastrointestinal tract, and kidneys formed but are not fully functional.
Week 4 (21–28 days)	¼ inch long; rudimentary head, trunk, arms; heart "practices" beating; spinal cord and two major brain lobes present.	**Month 7**	Gains ½–1 oz per day.
Week 5 (28–35 days)	Rudimentary kidney, liver, circulatory system, eyes, ears, mouth, hands, arms, and gastrointestinal tract; heart beats 65 times per minute, circulating its own newly formed blood.	**Months 8 and 9**	Gains about 1 oz per day; stores fat, glycogen, iron, folate, vitamins B_6 and B_{12}, riboflavin, calcium, magnesium, vitamins A, E, and D; functions of organs continue to develop. Growth rate declines near term. Placenta weighs 500–650 g (1–1½ lb) at term.
Week 7 (49–56 days)	½ inch long, weighs 2–3 g (less than a teaspoon of sugar); brain sends impulses, gastrointestinal tract produces enzymes, kidney eliminates some waste products, liver produces red blood cells, muscles work.		

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Photo 4.2 An embryo at 8 weeks after conception within the amniotic sac and attached by the umbilical cord to the placenta. At only 1 inch long and weighing 3–4 grams, all major organs have begun to form, as well as arms, legs, and toes.

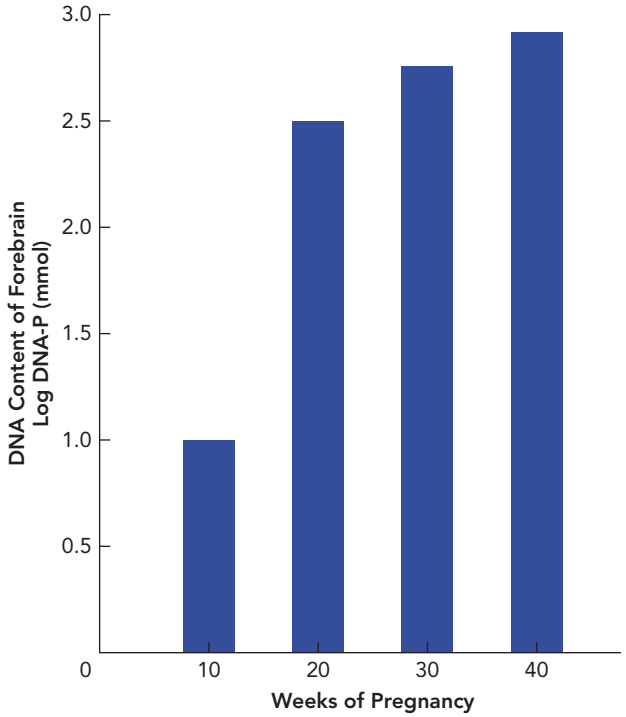


Figure 4.7 The critical period of cell multiplication of the forebrain. Growth in cell numbers is indicated by increases in DNA content of a given amount of tissue.

Sources: Bar graph developed by author from data in Dobbing, J., and Sands, J. Quantitative growth and development of the human brain. *Arch Dis Child.* 1973; 48:757–767; Rice D, Barone Jr., S. Critical periods of vulnerability for the developing nervous system: Evidence from humans and animal models. *Environmental health perspectives.* 2000 Jun; 108(suppl 3):511–533.

other insults occurring during critical periods of growth and development persist throughout life.[43]

Hyperplasia Critical periods of growth and development are characterized by hyperplasia, or an increase in cell multiplication. Because every human cell has a specific amount of DNA, periods of hyperplasia can be determined by noting times during gestation when the DNA content of specific organs and tissues increases sharply. The critical period of rapid cell multiplication of the forebrain, for example, is between 10 and 20 weeks of gestation (Figure 4.7).

The heart and the brain are the first organs that develop in humans and, along with the rest of the central nervous system, they are given priority access to energy, nutrient, and oxygen supplies. The heart is the first functional organ to develop and begins pumping blood and beating by day 21 or 22. The brain closely follows and development ends around day 25.[44] In conditions of low energy, nutrient, and oxygen availability, the needs of the central nervous system will be met before those of other fetal tissues, such as the liver or muscles. The adrenal glands come next after the central nervous system in the hierarchy of targets for preferential nutrient delivery.[45]

Deficits or excesses in nutrients supplied to the embryo and fetus during critical periods of cell multiplication can produce lifelong defects in organ and tissue structure and function. The organ or tissue undergoing critical periods of growth at the time of the adverse exposure will be affected most.[43] For example, the neural tube develops into the brain and spinal cord during weeks 3 and 4 after conception. If folate supplies are inadequate during this critical period of growth, permanent defects in brain or spinal cord formation occur, regardless of folate availability at other times. Other tissues—such as the pancreas, which does not undergo rapid cell multiplication until the third trimester of pregnancy—do not appear to be affected by the early shortage of folate.

Some degree of hyperplasia takes place in a number of organs and tissues in the first year or two after birth and during the adolescent growth spurt. Cells of the central nervous system, for instance, continue to multiply for about 2 years after birth, but at a much slower pace than early in pregnancy. Skeletal and muscle cells increase in number during the adolescent growth spurt.[46]

In utero and early life changes in DNA content of the brain have been investigated in fetuses, infants, and young children dying from non-nutritional causes and from undernutrition. Deficits in DNA content (or cell number) in the brains of children dying of protein-energy malnutrition is different than those dying from accidents (Figure 4.8). Deficits in DNA were apparent a few months after birth, indicating that severe malnutrition early in pregnancy reduced brain cell number *in utero*.[47]

Hyperplasia and Hypertrophy Cell multiplication continues at a lower rate after critical periods of cell multiplication and is accompanied by increases in the size of cells. This phase of growth can be seen in Figure 4.7, where it begins around 20 weeks in the forebrain when the rate of increase in DNA content slows. Cell size increases mainly due to an accumulation of protein and lipids inside of cells.

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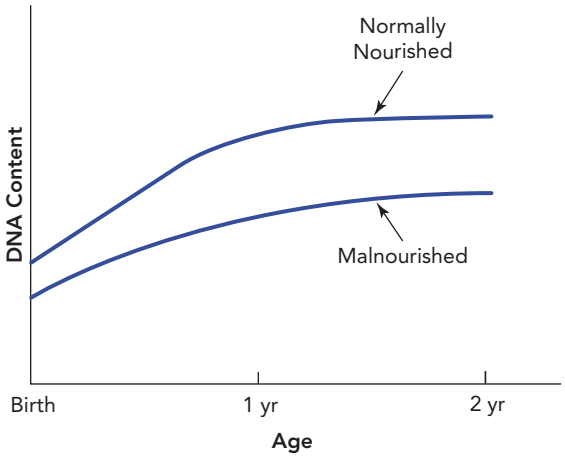


Figure 4.8 Patterns of change in the DNA content of the cerebellum of the brains of young children dying from non-nutritional causes and from undernutrition.

Sources: Patterns drawn by Judith Brown from data in. Winick, M. Malnutrition and brain development. *J Pediatr*. 1969. 74(6):667–679. SOO22347669801290; Antonow-Schlorke, I., Schwab, M., Cox, L. A., Li, C., Stuchlik, K., Witte, O. W., Nathanielsz, P. W., & McDonald, T. J. Vulnerability of the fetal primate brain to moderate reduction in maternal global nutrient availability. *Proceedings of the National Academy of Sciences*. 2011 Feb 15; 108(7):3011–3016.

Consequently, increases in cell size can be determined by measuring the protein or lipid content of cells. Specialized functions of cells, such as production of digestive enzymes by cells within the small intestine or neurotransmitters by nerve cells, occur along with increases in cell number and size.[22]

Hypertrophy Periods of hyperplasia-hypertrophy are followed by hypertrophy only. During this phase, cells continue to accumulate protein and lipids, and functional levels continue to grow in sophistication, but cells no longer multiply. Reductions in cell size caused by unfavorable nutrient environments or other conditions are associated with deficits in organ and tissue functions, such as reduced mental capabilities or declines in muscular coordination. Such functional changes can often be reduced or reversed later if deficits are corrected.[43]

Maturation The last phase of growth and development is maturation—the stabilization of cell number and size. This phase occurs after tissues and organs are fully developed later in life.

Fetal Body Composition

The fetus undergoes marked changes in body composition during pregnancy (Table 4.11). The general trend is toward progressive increases in fat, protein, and mineral content. Some of the most drastic changes take place in the last 5 weeks of pregnancy, when body fat, glycogen stores, and mineral content increase substantially.

Variation in Fetal Growth Given a healthy mother and fetal access to needed amounts of energy, nutrients, and oxygen, and freedom from toxins, fetal genetic growth



Publiphoto/Science Source



AP Images/Vadim Ghirda/Pool



AP Images/Eleoi Correa/Agencia Estado

Photo 4.3 The newborn on the top is disproportionately small for gestational age, the middle newborn is proportionately small for gestational age, and the newborn on the bottom is large for gestational age.

Table 4.11 Estimated changes in body composition of the fetus by time in pregnancy[42,48]

Component	10 Weeks	20 Weeks	30 Weeks	40 Weeks
Body weight, g	10	300	1,667	3,450
Water, g	<9	263	1,364	700
Protein, g	<1	22	134	446
Fat, g	<1	26	66	525
Sodium, meq	<1	32	136	243
Potassium, meq	<1	12	75	170
Calcium, g	<1	1	10	28
Magnesium, mg	<1	5	31	76
Iron, mg	<1	17	104	278
Zinc, mg	<1	6	26	53

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potential is achieved.[42] However, as evidenced by the relatively high rate of low birthweight in the United States, optimal conditions required for achievement of genetic growth potential often do not exist during pregnancy. Variations in fetal growth and development are not generally due to genetic causes but, rather, to environmental factors such as energy, nutrient, and oxygen availability, and to conditions that interfere with genetically programmed growth and development. Insulin-like growth factor-1 (IGF-1) is the primary growth stimulator of the fetus. It promotes uptake of nutrients by the fetus and inhibits fetal tissue breakdown. Levels of IGF-1 are sensitive to maternal nutrition; its levels are decreased by undernutrition. Low levels of IGF-1 decrease muscle and skeletal mass and produce asymmetrical growth.[45] Factors such as prepregnancy underweight status and shortness of height, low weight gain during pregnancy, poor dietary intakes, smoking, drug abuse, and certain clinical complications of pregnancy are associated with reduced fetal growth.[48,49]

Risk of illness and death varies substantially with size at birth and is particularly high for newborns experiencing intrauterine growth restriction (IUGR) also called fetal growth restriction (FGR).[48] For a portion of newborns, smallness at birth is normal and may reflect familial genetic traits. Because IUGR is complicated to determine, it is usually approximated by assessment of size for gestational age using a reference standard[50] (Table 4.12). Infants are generally considered likely to have experienced intrauterine growth congenital disability if their weight for gestational age or length is low. Newborns whose weight is less than the 10th percentile for gestational age are considered **small for gestational age (SGA)**. This determination is further categorized into asymmetrically small for gestational age (aSGA), also known as **disproportionately small for gestational age (dSGA),** and symmetrically small for gestational age (sSGA), also known as **proportionately small for gestational age (pSGA).**[51,52] Newborns who weigh less than the 10th percentile of weight for gestational age and have a head circumference that is above or below the 10th percentile for age or those Infants who have an increased brain-to-body ration are considered dSGA. If weight, length, and head circumference are less than the 10th percentile for gestational age, and the infant has a normal brain-to-body ratio, then the newborn is considered pSGA (Photo 4.3). Approximately 70–80 percent of SGA newborns in the United States are disproportionately small, and one-third are proportionately small.[42,53]

dSGA Infants who are disproportionately small for gestational age look skinny, wasted, and wrinkly. They tend to have small abdominal circumferences, reflecting a lack of glycogen stores in the liver, and little body fat. It appears that these infants have experienced *in utero* malnutrition in the third trimester of pregnancy and that it compromised liver glycogen and fat storage. Short-term episodes of malnutrition, such as maternal weight loss or low weight gain late in pregnancy that compromise energy,

Table 4.12 Percentiles of weight in grams for newborn gestational age[50]

Gestational Age (wk)	5th Pctl	10th Pctl	50th Pctl	90th Pctl	95th Pctl
20	249	275	412	772	912
21	280	314	433	790	957
22	330	376	496	826	1,023
23	385	440	582	882	1,107
24	435	498	674	977	1,223
25	480	558	779	1,138	1,397
26	529	625	899	1,362	1,640
27	591	702	1,035	1,635	1,927
28	670	798	1,196	1,977	2,237
29	772	925	1,394	2,361	2,553
30	910	1,085	1,637	2,710	2,847
31	1,088	1,278	1,918	2,986	3,108
32	1,294	1,495	2,203	3,200	3,338
33	1,513	1,725	2,458	3,370	3,536
34	1,735	1,950	2,667	3,502	3,697
35	1,950	2,159	2,831	3,596	3,812
36	2,156	2,354	2,974	3,668	3,888
37	2,357	2,541	3,117	3,755	3,956
38	2,543	2,714	3,263	3,867	4,027
39	2,685	2,852	3,400	3,980	4,107
40	2,761	2,929	3,495	4,060	4,185
41	2,777	2,948	3,527	4,094	4,217
42	2,764	2,935	3,522	4,098	4,213
43	2,741	2,907	3,505	4,096	4,178
44	2,724	2,885	3,491	4,096	4,122

NOTE: Pctl = percentile.

Source: Alexander, G., et al. A United States National Reference for Fetal Growth. *Obstet Gynecol. 1996; 87*:163–168, table 2. Reprinted with permission from Wolters Kluwer Health. Grantz, K. L., et al. Unified standard for fetal growth: The Eunice Kennedy Shriver National Institute of Child Health and Human Development Fetal Growth Studies. *AJOG*. April 2022; 226(4):576–587. doi: https://doi.org/10.1016/jajog.2021.12.006.

small for gestational age (SGA) Newborn weight is less than 10th percentile for gestational age. Also called *small for date* (*SFD*).

disproportionately small for gestational age (dSGA) Newborn weight is less than 10th percentile of weight for gestational age; length and head circumference are normal. Also called *asymmetrical SGA*.

proportionately small for gestational age (pSGA) Newborn weight, length, and head circumference are less than 10th percentile for gestational age. Also called *symmetrical SGA*.

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nutrient, or oxygen availability appear to be related to dSGA.[42,51,52] These infants generally have smaller organ sizes but the normal number of cells in organs and tissues.

Infants who are dSGA are at risk of developing the "hypos" after birth (hypoglycemia, hypocalcemia, hypomagnesiumenia, and hypothermia). If the period of maternal undernutrition was short, dSGA infants tend to experience good catch-up growth with nutritional rehabilitation.[45] Unfortunately, disproportionately small infants tend to perform less well academically and are at greater risk than other infants for heart disease, hypertension, and type 2 diabetes in the adult years.[28,42,54]

pSGA Proportionately SGA newborns look small but well proportioned. It is believed that these infants experience long-term malnutrition *in utero*, due to factors such as prepregnancy underweight, consistently low rates of maternal weight gain in pregnancy and the corresponding inadequate dietary intake, maternal disease, or chronic exposure to alcohol.[22]

Because nutritional insults exist during critical periods of growth early in pregnancy, pSGA infants generally have a reduced number of cells in organs and tissues. These babies tend to exhibit fewer health problems at birth than do dSGA infants, but catch-up growth is poorer, even with nutritional rehabilitation. On average, pSGA infants remain shorter and lighter and have smaller head circumferences throughout life than do infants born **appropriate for gestational age (AGA)** or **large for gestational age (LGA)**.[51,52,55]

The goal of nutritional rehabilitation for pSGA infants should be to catch up in weight and length, and not just weight. This goal appears to be easier to reach if pSGA infants are breastfed. Excessive weight gain by pSGA infants appears to increase the risk of obesity, hypertension, heart disease, and type 2 diabetes later in life.[56,57]

LGA Newborns with weights greater than the 90th percentile for gestational age are considered to be large for gestational age. Although it is difficult to predict LGA, it appears to be related to prepregnancy obesity, poorly controlled diabetes in pregnancy, excessive weight gain in pregnancy, and possibly other factors.[58,59]

appropriate for gestational age (AGA) Weight, length, and head circumference are between the 10th and 90th percentiles for gestational age.

large for gestational age (LGA) Weight for gestational age exceeds the 90th percentile for gestational age. Also defined as birthweight greater than 4,500 g (10 lb) and referred to as *excessively sized for gestational age*, or *macrosomic*.

shoulder dystocia Blockage or difficulty of delivery due to obstruction of the birth canal by the infant's shoulders.

cerebral palsy A group of disorders characterized by impaired muscle activity and coordination present at birth or developed during early childhood.

Except for infants born to women with poorly controlled diabetes during pregnancy or other health problems, LGA newborns experience far lower illness and death rates than do SGA infants, and they tend to be taller later in life.[60,61] Delivery and postpartum complications in mothers, however, tend to be higher with LGA newborns, and these include increased rates of operative delivery, **shoulder dystocia**, and postpartum hemorrhage.

Nutrition, Miscarriage, and Preterm Delivery

Several other pregnancy outcomes are related in part to maternal nutrition. Highlighted here are the roles played by nutrition in miscarriage and preterm delivery.

Miscarriages Over 30 percent of implanted embryos are lost by reabsorption into the uterus or expulsion before 20 weeks of pregnancy. Roughly a third of these losses are recognized as a miscarriage and the remaining occur before the pregnancy is realized by the mother.[61,62] Such early losses of embryos and fetuses are thought to be primarily caused by genetic abnormalities, immunological disorders, thyroid disorders, hormonal imbalances, reproductive tract infections, and drug or alcohol abuse.[62,63,64]

The presence of nausea and vomiting early in pregnancy is related to a low risk of miscarriage. Nausea and vomiting may occur as a side effect of healthy changes in hormone levels.[54] Women who enter pregnancy underweight are at a slightly higher risk of miscarriage than are normal women. Overweight women with a BMI 25–30 may have a higher rate of miscarriage compared to women with a normal BMI of 18.5 to < 25. Overweight women with a BMI of > 30 have a higher rate of miscarriage and recurrent miscarriage compared to women with a normal BMI. Studies have shown an association with increased miscarriage risk proportionately with increases in BMI.[65–67] High levels of oxidative stress in women in the first half of pregnancy, and in men prior to conception, have been linked to a substantial increase in the risk of miscarriage.[68,69]

Miscarriage often generates feelings of guilt and individuals may blame themselves for the loss, even though chances are very high that it was not due to anything they did. Miscarriages are common and reflect the fact that human reproduction is far from perfectly efficient.[70,71]

Preterm Delivery Infants born preterm are at greater risk than other infants of death, neurological problems reflected later in low IQ scores, attention deficit-hyperactivity disorders, enrollment in special education, congenital malformations, and chronic health problems such as **cerebral palsy**. The risk for these outcomes increases as gestational age at birth decreases.[72] Infants born very preterm (less than 34 weeks) commonly have problems related to growth, digestion, respiration, and other conditions due to immaturity.[73] Low stores of fat, essential fatty acids, glycogen, calcium, iron, zinc, and other nutrients in very preterm infants may also interfere with growth and health after delivery.[74] Additionally, breast-milk content of

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thiamin, riboflavin and vitamins A, C, D, and B_{12} may be low in women who have inadequate intake of these vitamins during the third trimester of pregnancy.[75-79]

Use of multivitamin or folic acid supplements and adequate folate intake before and during early pregnancy appear to be associated with a decreased risk of preterm delivery.[80,81] Caffeine intake of up to 300 mg per day (the equivalent of 2–3 cups of coffee) does not appear to be related to the risk of preterm delivery,[82,83] while intake of one to three fish meals a week appears to be protective.[84–86] Healthy dietary patterns, characterized by the regular consumption of foods such as fish, chicken, whole grains, vegetables, fruits, and legumes are associated with a lower risk of preterm versus a high-fat, high added sugar, and refined grain products dietary pattern.[84,85,87]

Women who are underweight and gain less than the recommended amount of weight during pregnancy are at particularly high risk for preterm delivery. Women entering pregnancy in an obese weight status are also at increased risk, but to a lesser extent than is the case for underweight women.[80,88] Additionally, it appears that women who exercise regularly during pregnancy are at lower risk of preterm delivery than are women who are inactive.[89,90]

Within the past few years, a number of studies have identified increased levels of triglycerides and elevated levels of markers of inflammation and oxidative stress in the first half of pregnancy in women delivering preterm.[69,91,92] Elevated levels of triglycerides appear to be present early in pregnancy, before major increases in blood lipid levels generally occur. This result is raising the question of whether women with high levels of lipids coming into pregnancy are at increased risk of preterm delivery. Indications of increased inflammatory markers and oxidative stress early in pregnancy suggest that chronic inflammation and oxidative stress may be involved in the development of physiological conditions that favor preterm delivery.[69,93] Whether diets rich in antioxidant nutrients and measures that reduce lipid levels and oxidative stress decrease the risk for preterm delivery is not currently known, but suspected.[61]

Although preterm delivery is a major health problem in the United States, its etiology remains unclear, and the search for effective prevention programs continues. A portion of preterm deliveries appears to be related to genital tract infections, insufficient uterine-placental blood flow, placental abruption (bleeding into the uterus), prepregnancy underweight, low weight gain in pregnancy, short interpregnancy interval (less than 6 months), and high levels of psychological or social stress. It is also fairly common in women who have previously delivered preterm.[74]

Developmental Origins of Health and Disease

Rather amazing discoveries about nutrition and embryonic and fetal growth and development are being made currently. Not that long ago it was assumed that the fetus would take whatever nutrients and other substances it needed for normal growth and development from the mother. It was widely assumed that only extremely poor diets were hazardous to the fetus, and that the mother's health would be compromised by poor diets rather than fetal health.[94,95] Advances in knowledge have changed old assumptions. They point to the critical importance of maternal nutrition before and during embryonic, placental, and fetal development on chronic disease risk.[17,28,96,97] It is now widely concluded that chronic disease does not begin to develop during childhood or the adult years, but rather may begin *in utero*.

Relationships between maternal and fetal exposures during pregnancy and later disease risk in offspring are now generally referred to as *developmental origins of health and disease*. In the past, it was referred to as the *fetal origins hypothesis*, *developmental programming*, and the *Barker hypothesis*. (The terms used to describe this area of knowledge are evolving almost as rapidly as the research.)

Much of the evidence that relates *in utero* exposures to later disease in humans comes from studies showing increased risk for high levels of visceral fat, obesity, heart disease, hypertension, type 2 diabetes, gestational diabetes, and chronic bronchitis in small, short, and underweight newborns (Table 4.13). Each of these conditions reflect less than optimal, embryonic, placental, and fetal growth and development.[17] One study showed surrogate pregnancies were more likely to have higher rates of preterm births with lower gestational age and birth weight compared to spontaneous pregnancies. Higher obstetrical complications were seen in the surrogate group and included hypertension and gestational diabetes. Infants born to surrogates in this study had increased perinatal adverse outcomes.[98] Maternal nutrition appears to play key roles in mechanisms that lead to later disease risk because it is a major factor affecting fetal growth and development. Although smallness and thinness at birth are recognized as risk factors for later disease development, specific aspects of maternal nutrition unrelated to size at birth have also been related to disease development later in life.

Relatively small reductions in weight or disproportions in newborn size have been related to increased later disease risk. Risk of cardiovascular disease (heart disease and stroke), for instance, is associated with birthweights below 7.5 lb (3,360 g)—weights that are often considered "normal" (Table 4.14).[96,97]

Table 4.13 Examples of noncommunicable diseases related to smallness or thinness at birth[96,97,118]

Allergies	Obesity
Autoimmune diseases	Osteoporosis
Bronchitis	Ovarian cancer
Cardiovascular disease	Polycystic ovary syndrome
Decreased bone mineral content	Schizophrenia
Gestational diabetes	Short stature
Hypertension	Stroke
Irritable bowel syndrome	Subfertility in males
Kidney disease	Suicide risk
Metabolic syndrome	Type 2 diabetes
Mood disorders	

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Table 4.14 Association of birthweight with the risk of cardiovascular disease in the U.S. Nurses Study[99]

Birthweight	Relative Risk of:	
	Heart Disease	Stroke
<5 lb (2,240 g)	1.5	2.3
5–5½ lb (2,240–2,500 g)	1.3	1.4
5½–7 lb (2,500–3,136 g)	1.1	1.3
7–8½ lb (3,136–3,808 g)	1.0	1.0
8½–10 lb (3,808–4,480 g)	1.0	1.0
>10 lb (>4,480 g)	0.7	0.7

Mechanisms Underlying Developmental Programming The process of human growth and development *in utero* is not inflexible or solely determined by genes. It is also influenced by environmental exposures. This characteristic of early growth and development has been termed **developmental plasticity**. The term reflects the ability of the embryo and fetus to modify gene functions when exposed to adverse conditions that threaten its immediate chances of survival. These modifications can foster fetal survival *in utero* and later in life, given the same set of environmental circumstances. They can increase the risk of certain diseases, however, if environmental conditions change.[16,17]

Environmental exposures modify development through **epigenetic** mechanisms that program gene function while not changing DNA structure. Epigenetic mechanisms influence growth and development by silencing certain genes (or turning them off) and activating (turning on) others. Epigenetic changes may last throughout all cell divisions for the remainder of the cell's life and for multiple generations.[16,17]

Examples of Developmental Programming Effects Results of studies during human pregnancy, and laboratory studies involving animals, point to ways in which *in utero* energy and nutrient exposures may prompt fetal adaptations that affect gene function programming and later disease risk. Energy availability has been a major focus of many of these studies because of its importance to fetal growth and development. In human studies, energy available for fetal growth and development is often assessed by pregnancy weight change and newborn birth size.

An inadequate availability of glucose during fetal growth and development would hinder central nervous system (CNS) development and threaten fetal survival. Mechanisms are set in place, however, that triage available glucose to the central nervous system. This change represents an adaptation by the body to how glucose utilization is programmed to operate.

What adaptations are made to ensure the CNS gets priority access to glucose? Studies indicate that the expression of genes that produce insulin receptors on muscle cell membranes may be suppressed in response to a low availability of glucose. This increases insulin resistance and decreases uptake of glucose by muscle cells, and reduces their growth. It also increases the availability of glucose for CNS development.

Adaptations that decrease muscle utilization of glucose and reduce muscle size may serve the offspring well later in life if food availability and intake are limited. If food is abundant and food intake is high, however, such adaptations may lead to elevated blood levels of glucose and insulin. These changes may increase the risk of obesity, type 2 diabetes, gestational diabetes, and other disorders associated with insulin resistance.[16,17,28,99]

Increased susceptibility to insulin resistance and weight gain in infants experiencing nutritional insults *in utero* has been attributed to a *thrifty phenotype*, or gene functions programmed *in utero* to conserve energy.[28]

The function of genes involved in cholesterol metabolism appears to be modified in males with birthweights less than 7 lb (3.2 kg). In these individuals, production of "good" cholesterol (HDL) tends to decrease in response to high-fat, high-saturated-fat diets. HDL cholesterol production generally increases in males with higher birthweights in response to this type of diet. High blood levels of HDL cholesterol are protective against heart disease.[100,101]

Some studies have shown a link between maternal nutritional exposures during pregnancy and later disease risk in infants with a wide range of birthweights. Low weight gain around mid-pregnancy, for example, has been associated with higher blood pressure in children, and low levels of maternal body fat during pregnancy with increased risk of heart disease in offspring.[100]

Maternal nutrition is thought to underlie many of the relationships between *in utero* exposures and later disease risk, but other important factors are also involved. Exposures around the time of conception and during pregnancy such as infection, preexisting conditions such as obesity, hypertension, and diabetes, drugs, and environmental toxins also affect later disease risk. Adverse exposures during infancy when organs and tissues are still developing also can affect gene programming and later disease risk.[16,102,103]

Limitations in Knowledge about the Developmental Origins of and Health and Disease Many questions about the influence of maternal and fetal nutritional exposures on later disease risk remain. Which specific nutritional exposures are responsible for changes in gene function and increased disease risk? How do the genetic characteristics of sperm influence fetal vulnerability to developmental programming? What levels of energy and nutrient availability are related to the optimal functioning

developmental plasticity The concept that development can be modified by particular environmental conditions experienced by a fetus or infant.

epigenetic (*epi* = over, above) Heritable changes in gene function that do not entail a change in DNA sequence. Epigenetic modifications play a crucial role in the silencing and expression of noncoding portions of genes.

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of genes? How can we "rescue" or repair detrimental epigenetic changes so that they correspond to a person's actual rather than *in utero* or early-life exposures? Progress is being made toward finding out answers to each of these questions. The implications of the associations between maternal, paternal, and fetal nutrition and adult disease risk are immense.

Current knowledge of relationships between maternal nutrition exposures and later disease risk can be applied in practice. For example, we know that entering pregnancy in good health, a healthy dietary pattern before and during pregnancy, gaining the appropriate amount of weight, and reducing fetal exposure to potentially harmful substances can benefit later health in infants.[99,104]

4.4 Pregnancy Weight Gain

Weight gain during pregnancy is an important consideration because newborn weight and health status tend to improve with adequate weight gain. Birthweights of infants born to women with weight gains of 15 lb (7 kg), for example, average 3,100 g (6 lb 14 oz). This weight is about 500 g less than the average birthweight of 3,600 g (8 lb) in women gaining 30 lb (13.6 kg). Rates of low-birthweight infant births are higher in females gaining too little weight during pregnancy.[105] Weight gain during pregnancy is an indicator of plasma volume expansion and positive calorie balance, and provides a rough index of dietary adequacy.[106]

Multiple studies show broad agreement on amounts of weight gain that are related to the birth of infants with weights that place them within the lowest category of risk for death or health problems.[54] Yet how much weight should be gained during pregnancy remains a socially hotly debated topic. Earlier in the last century, when gains were routinely restricted to 15 or 20 pounds, weight gain in pregnancy was seen as the cause of pregnancy hypertension, difficult deliveries, and obesity in women. Pregnant women would be placed on low-calorie diets, were prescribed diuretics and amphetamines, and urged to use saccharin to limit weight gain.[107] None of these notions have been shown to be valid. Social biases related to body weight and shape of females are an important reason to apply recommendations for weight gain in pregnancy based on scientific evidence.

Pregnancy Weight Gain Recommendations

Current recommendations for weight gain in pregnancy are based primarily on gains associated with the birth of healthy-sized newborns.[108,109] Prepregnancy weight status influences the relationship between weight gain and birthweight (Figure 4.9). The higher the weight before pregnancy, the lower the weight gain needed to produce healthy-sized infants.

Because underweight women tend to retain some of the weight gained in pregnancy for their own needs, they need to gain more weight in pregnancy than do other women. Women who are overweight and obese, on the other hand, are able to use a portion of their energy stores to support fetal growth, so they need to gain less (Table 4.15).[110]

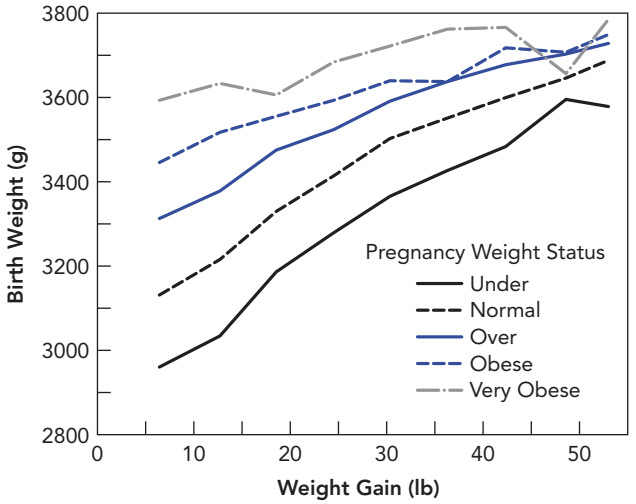


Figure 4.9 Pregnancy weight gain by prepregnancy weight status and birthweight.

Sources: Brown, J. E. *Clinical Nutrition.* 1988; 7(Fig. 1):186. Reprinted by permission from Elsevier; Morisset, A. S. Dubois, L., Colapinto, C. K. Luo, Z. C., & Fraser, W. D. Prepregnancy body mass index as a significant predictor of total gestational weight gain and birth weight. *Can J Diet Pract Res.* 2017 Feb 1; 78(2):66–73.

Duration of gestation, smoking, maternal health status, **gravida**, and **parity** also influence birthweight. Consequently, gaining a certain amount of weight during pregnancy does not guarantee that newborns will be a healthy size. It does improve the chances that this will happen, however.

Approximately 32 percent of U.S. women gain within the recommended weight ranges during pregnancy.[108,111] For all except the obese, women who gain within the recommended ranges are approximately half as likely to deliver low-birthweight or SGA newborns as are women who gain less. Rates of LGA newborns, Caesarean-section deliveries, and postpartum weight retention tend to be

Table 4.15 Pregnancy weight gain recommendations[108]

Prepregnancy Weight Status Body Mass Index	Recommended Weight Gain
Underweight, <18.5 kg/m^2	28–40 lb (12.7–18.2 kg)
Normal weight, 18.5–24.9 kg/m^2	25–35 lb (11.4–15.9 kg)
Overweight, 25–29.9 kg/m^2	15–25 lb (6.8–11.4 kg)
Obese, 30 kg/m^2 or higher	11–20 lb (5.0–9.1 kg)
Twin pregnancy	25–54 lb (11.4–24.5 kg)

gravida Number of pregnancies a woman has experienced.

parity The number of previous deliveries experienced by a woman; *nulliparous* = no previous deliveries, *primiparous* = one previous delivery, *multiparous* = two or more previous deliveries. Women who have delivered infants are considered to be *parous*.

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higher when pregnancy weight gain by women with high BMIs exceeds that recommended.[104,105] These effects are more pronounced when weight gain is high during the first half of pregnancy.[105,109,112–114] It appears that insulin resistance is related to excessive weight gain during pregnancy and some of the adverse neonatal outcomes.[115]

Concern has been expressed about the relationship between excessive weight gain during pregnancy and the risk of obesity in children. There appears to be a relationship between excessive weight gain during pregnancy and higher body fat levels in newborns.[116] The effects of weight gain, however, are dwarfed by the influence of parental obesity and environmental factors on child weight status.[116,117]

Restriction of pregnancy weight gain to levels below the recommended ranges is not recommended. It does not decrease the risk of pregnancy-related hypertension and is associated with increased infant death and low birthweight, and poorer offspring growth and development.[118] In addition, low weight gain in pregnancy may increase the risk that infants will develop heart disease, type 2 diabetes, hypertension, and other types of chronic disease later in life.[48,109,119]

Rate of Pregnancy Weight Gain Rates at which weight is gained during pregnancy appear to be as important to newborn outcomes as is total weight gain. Low rates of gain in the first half of pregnancy may slow fetal growth and result in reduced birthweight and thinness.[120] For underweight and normal-weight women, rates of gain of less than 0.5 pound (0.25 kg) per week in the second half of pregnancy, and of less than 0.75 pound (0.37 kg) per week in the third trimester of pregnancy, double the risk of preterm delivery and SGA newborns. For overweight and obese women, rates of gain of less than 0.5 pound (0.25 kg) per week in the third trimester also double the risk of preterm birth.[121] Third-trimester weight gains exceeding approximately 1.5 pounds a week (0.7 kg), however, add little to birthweight in normal-weight and heavier women, and may increase postpartum weight retention.[122]

Rate of weight gain is generally highest around midpregnancy—which is prior to the time the fetus gains most

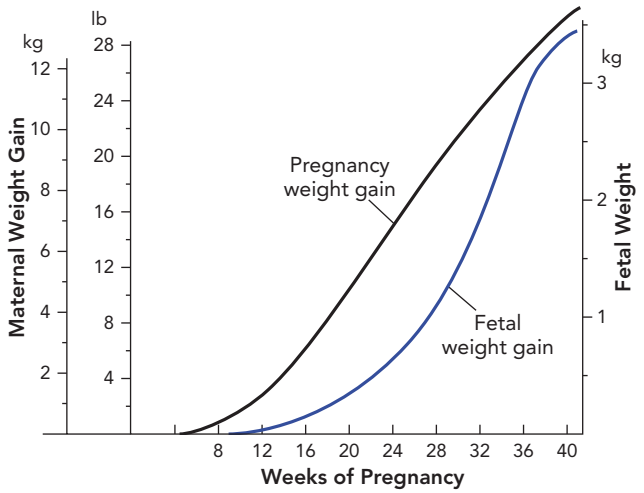


Figure 4.10 Rates of maternal and fetal weight gain during pregnancy.[120]
Source: Curves drawn by Judith E. Brown from research data.[107]

of its weight (Figure 4.10). In general, the pattern of gain should be within a few pounds of that represented by the weight-gain curves for pregnancy, an example of which is shown in Figure 4.11.[108] Some weight (3–5 lb) should be gained in the first trimester, followed by gradual and consistent gains thereafter. The rate of weight gain often slows a bit a few weeks prior to delivery, but as is the case for the rest of pregnancy, weight should not be lost until after delivery.[120]

Composition of Weight Gain in Pregnancy A question often asked by pregnant women is, "Where does the weight gain go?" The fetus actually comprises only about a third of the total weight gained during pregnancy in women who enter pregnancy at normal weight or underweight. Most of the rest of the weight is accounted for by the increased weight of maternal tissues (Table 4.16).

Body Fat Changes Women who are pregnant store a significant amount of body fat in normal pregnancy in order to meet their own and fetus energy needs, and

Table 4.16 Components of weight gain during pregnancy for healthy, normal-weight women delivering a 3,500-g (about 8-lb) infant at term[17,21,24]

	Weight Gain, Grams			
Component	**10 Weeks**	**20 Weeks**	**30 Weeks**	**40 Weeks**
Fetus	5	300	1,500	3,550
Placenta	20	170	430	670
Uterus	140	320	600	1,120
Amniotic fluid	30	350	750	896
Breasts	45	180	360	448
Blood supply	100	600	1,300	1,344
Extracellular fluid	0	265	803	3,200
Maternal fat stores	315	2,135	3,640	3,500
Total weight gain at term 14.7 kg or 32 lb				

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Name:

Weight Categories for Women According to Height and Pre-pregnancy Weight (ibs)[1]:

Height	Under Weight (BMI <18.5)	Normal Weight (BMI 18.5–24.9)	Over Weight (BMI 25–29.9)	Obese (BMI ≥ 30)
4′7″	<80	80–107	108–128	>128
4′8″	<83	83–111	112–133	>133
4′9″	<86	86–115	116–138	>138
4′10″	<89	89–119	120–143	>143
4′11″	<92	92–123	124–148	>148
5′	<95	95–127	128–153	>153
5′1″	<98	98–132	133–158	>158
5′2″	<101	101–136	137–163	>163
5′3″	<105	105–140	141–169	>169
5′4″	<108	108–145	146–174	>174
5′5″	<111	111–149	150–179	>179
5′6″	<115	115–154	155–185	>185
5′7″	<118	118–159	160–191	>191
5′8″	<122	122–164	165–196	>196
5′9″	<125	125–168	169–202	>202
5′10″	<129	129–173	174–208	>208
5′11″	<133	133–178	179–214	>214
6′	<137	137–183	184–220	>220
6′1″	<140	140–189	190–227	>227
6′2″	<143	143–194	195–233	>233
6′3″	<148	149–199	200–239	>239

BMI = Weight (lbs.)/Height (in.)² X 703

Recommended Weight Gain[1]:

Mark One:	Single	Twins
☐ Underweight	**28–40 lbs.**	N/A
☐ Normal	**25–35 lbs.**	37–54 lbs.
☐ Overweight	**15–25 lbs.**	31–50 lbs.
☐ Obese	**11–20 lbs.**	25–42 lbs.

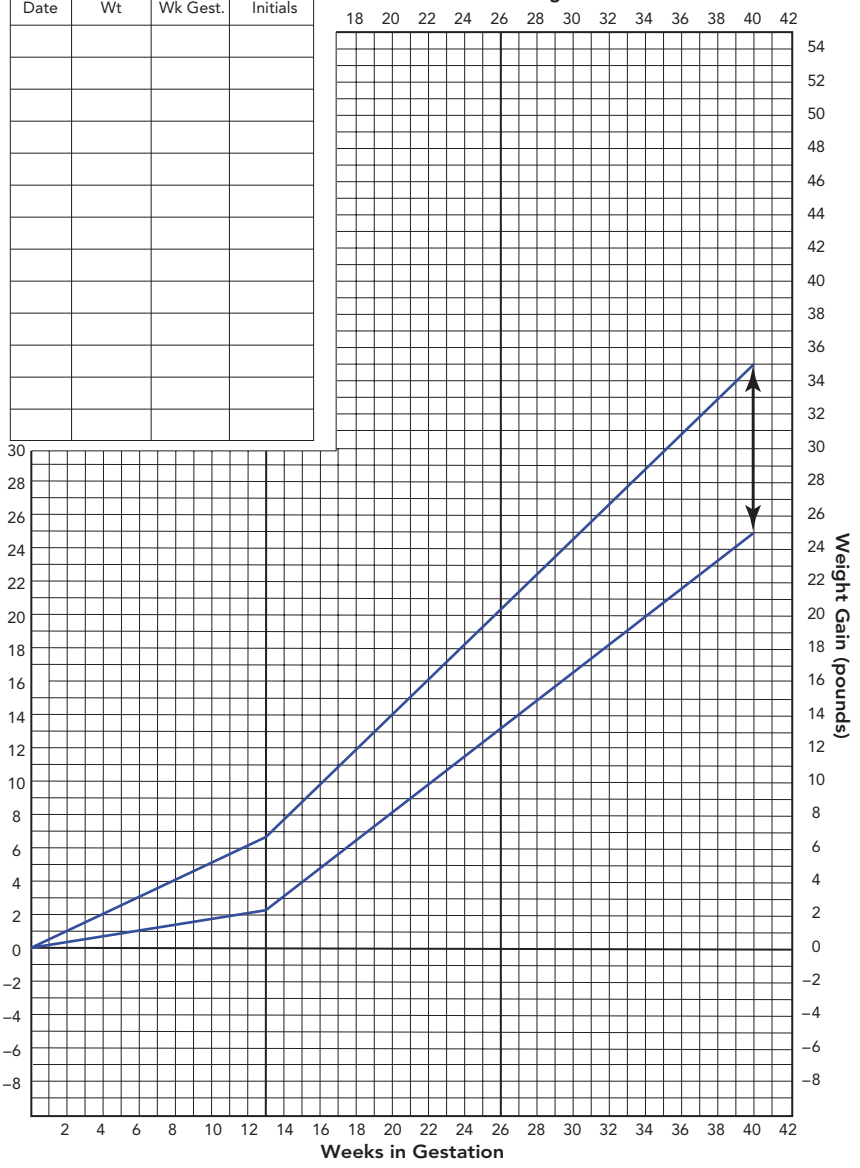
Pre-pregnancy Weight: _____

Height: _____

1
IOM,2009. Weight Gain During Pregnancy: Reexamining the Guidelines. Washington,DC: National Academies Press.
2
Per Personal Communication with the Committee to Reexamine IOM Pregnancy Weight Guidelines

Date	Wt	Wk Gest.	Initials

Pre-pregnancy Normal Weight Range
Prenatal Weight Grain Grid[2]



CDPH 4472B2 (03/10)

Figure 4.11 An example of a pregnancy weight gain graph based on the IOM charts for normal weight pregnant women from the California Department of Maternal and Child Health.[a]

[a]A weight gain graph for pregnant women in each of the four prepregnancy weight status groups can be located from: www.cdph.ca.gov/pubsforms/forms/Pages/MaternalandChildHealth.aspx

Source: State of California—Health and Human Services Agency, California Department of Public Health. Available at www.cdph.ca.gov/pubsforms/forms/CtrldForms/cdph4472b2.pdf.

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to prepare for the energy demands of lactation. Body fat stores increase the most between 10 and 20 weeks of pregnancy, or before fetal energy requirements are highest. Levels of stored fat tend to decrease before the end of pregnancy. Only 0.5 kg of the approximately 3.5 kg of fat stored during pregnancy is deposited in the fetus.[17,123]

Postpartum Weight Retention About 30 years ago, the average amount of weight retained by women 1 year after delivery was about 2 pounds.[123] Currently, that average is higher and reflects the fact that women are gaining more weight during pregnancy and losing less after delivery. About half of all women gain above the recommended Institute of Medicine (IOM) weight ranges during pregnancy. Women who are underweight are least likely to gain above the IOM range, but they tend to retain several pounds more of the weight gained postpartum.[105] Weight gains within the IOM ranges are associated with a 6.6-pound (3-kg) lower weight retention 3 years' postpartum than are gains above the IOM ranges.[124]

Women of all prepregnancy weight statuses tend to lose about 14 pounds (6.4 kg) within the first 6 weeks after delivery.[125] After that, the amount of weight retained postpartum varies, mainly based on the amount of weight gained during pregnancy and prepregnancy weight status.[126] Women who gain over 44 pounds (20 kg) during pregnancy, for example, weigh on average 9–10 pounds (around 4.3 kg) more than their prepregnancy weight at 1 year postpartum.[110] The rate of weight loss beyond 6 weeks after delivery decreases, on average, among women who entered pregnancy obese compared to women who are underweight, normal, and overweight. Women who are overweight and obese are most likely to gain weight between pregnancies.[127]

Prevention of Excessive Body Weight A number of pregnancy weight gain management programs have been developed to help limit excessive weight gain during pregnancy. Effective programs tend to include weight gain, diet, and exercise counseling and monitoring. On average, women participating in these programs gain 2.6–3.1 pounds (1.2–1.4 kg) less than women in control groups.[128,129]

Weight losses of 1–2 pounds per month postpartum with diet and exercise are appropriate.[125] Exclusive breastfeeding may facilitate weight loss to a small extent in postpartum women who gained within the IOM ranges. It appears to have little or no effect on weight loss in women who gain above the ranges. It is concluded that breastfeeding should not be promoted as an effective weight loss method but, rather, based on its own merits.[130]

4.5 Nutrition and the Course and Outcome of Pregnancy

The history of beliefs about the effects of maternal diet on the course and outcome of pregnancy is rife with superstition, ill-founded and hazardous conclusions, and unhelpful suggestions. For example, women in ancient Rome were advised to eat mice often if they wanted to have a child with dark eyes.[131] Societies have shared a belief in the importance of "eating right" during pregnancy for the child's sake, but actual knowledge about maternal nutrition and the course and outcome of pregnancy has been acquired only relatively recently.

Famine and Pregnancy Outcome

Much of the scientific interest in the effects of maternal nutrition on the course and outcome of pregnancy comes from studies done in the first half of the twentieth century. Ecological studies on effects of famines in Europe and Japan during World War II on the course and outcome of pregnancy demonstrated potential negative, as well as positive, effects of food intake on fertility and newborn outcomes.

The Dutch Hunger Winter, 1943–1944 As mentioned briefly in Chapter 2, people in many parts of Holland experienced severe food shortages for an 8-month period during World War II due to enemy occupation of major cities. Although people in Holland were generally well nourished and had a reasonable standard of living before the disaster, conditions rapidly deteriorated during the famine. In addition to intakes that averaged only about 1,100 kcal and 34 g of protein per day, fuel was in low supply and the winter was harsh.

Carefully kept records by health officials showed a sharp decline in pregnancy rates of over 50 percent during the famine, an effect attributed to absent and irregular menstrual periods. Average birthweight declined by 372 g (13 oz), delivery of low-birthweight infants increased by 50 percent, and rates of infant deaths increased. Birthweight did not fully "catch up" in infants born to women exposed to famine early in pregnancy, even if they received enough food later in pregnancy. This result supports the notion that the fetal growth trajectory may be established early in pregnancy and that early nutritional deprivations limit fetal growth regardless of food intake later in pregnancy.[132]

Although the Dutch famine was associated with major declines in fertility and newborn health and survival, the rather good nutritional status of women prior to the famine likely protected pregnant women and their infants' health. Healthy fertility status and newborn outcomes returned within a year after the famine ended.[133] Studies undertaken in the last 30 years on adults who were born to women during the hunger winter (the Dutch famine cohort) show relationships between the timing of famine during pregnancy and adult offspring health outcomes (Table 4.17).

The Siege of Leningrad, 1942 Unlike people in Holland, the population in Leningrad (now called St. Petersburg) had experienced moderate deprivations in nutritional status and quality of life prior to the famine. As was the case for women who were pregnant in Holland, the famine in Leningrad resulted in average intakes of approximately

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Table 4.17 Exposure to the Dutch World War II famine by time in pregnancy and adult offspring health risks[134,135]

Period of Famine		
First Trimester	**First and/or Second Trimester**	**Second Half of Pregnancy**
Schizophrenia	Antisocial personality disorder	Decreased glucose tolerance
High LDL and low HDL cholesterol		
High body weight and central body fat		
Infertility		
Neural-tube defects		

1,100 kcal/day. Infertility and low-birthweight rates increased over 50 percent, infant death rates rose, and birthweights dropped by an average of 535 g (1.2 lb) during the famine.[136] Rates of pSGA newborns also increased, suggesting that the poor nutritional status of women coming into pregnancy and persistent undernutrition during pregnancy interfered with critical periods of fetal growth.

Food Shortages in Japan Effects of World War II–associated food shortages on reproductive outcomes in Japan were similar to those observed in Holland. Japanese women tended to be well nourished prior to the shortages. Lack of food before and during pregnancy was reflected in decreased fertility status among women and in reductions in birthweight that averaged 200 g (0.44 lb).

Social and economic improvements occurring in Japan after the war led to increased availability of many foods, including animal products. This higher plane of nutrition achieved during the postwar years in Japan was accompanied by major increases in newborn size and the "growing up" of Japanese children. In a trend that continues today, subsequent generations of Japanese adults averaged 2 in. taller than the previous generation.[137] Infant mortality in Japan, which ranked among the highest for industrialized nations prior to World War II, declined incredibly after the war and remains well below rates in the United States and in a number of other developed countries.[138]

The Famine in China, 1959–1961 The Chinese famine of 1959–1961 was the largest in human history and mainly affected individuals living in rural areas. Little information about the diet and lifestyles of people in China during that time is available. Given available data, it is concluded that famine exposure during pregnancy was associated with a large reduction in births, an increased risk of type 2 diabetes, a threefold increase in the odds of developing hypertension, in adults versus adults not born during the famine.[139] The risk of type 2 diabetes was higher in famine-exposed offspring exposed to a food-rich urban environment after birth.[99]

Food Shortages in Other Areas Food shortages continue to occur in various parts of the world and to adversely affect fertility and the course and outcome of pregnancy. Effects have become predictable, such that declines in fertility and newborn size and vitality are viewed as part of the consequences of such disasters. For example, the siege of Sarajevo, which decreased food availability during 1993–1994, led to reduced caloric and nutrient intakes during pregnancy, reduced maternal weight gain and newborn weights, and increased rates of perinatal mortality and congenital anomalies.[140] Birthweight did not fully catch up in infants born to women exposed to famine early in pregnancy, even if they received enough food later in pregnancy. This result supports the notion that the fetal growth trajectory may be established early in pregnancy and that early nutritional deprivations limit fetal growth regardless of food intake later in pregnancy.[132] It is suspected that epigenetic mechanisms likely play important roles in relationships between prenatal famine and adverse outcomes later in life.[141]

4.6 Energy and Nutrient Needs During Pregnancy

Nutrient requirements during pregnancy are not static. They vary during the course of pregnancy depending on prepregnancy nutrient stores, body size and composition, physical activity levels, stage of pregnancy, and health status. For the most part, nutrient needs can be and are optimally met by consuming well balanced, adequate, and healthful diets consisting of basic foods. Healthful diets established during pregnancy can last well beyond pregnancy and benefit health for life.

Carefully conducted studies of diet and pregnancy outcome in the first half of the twentieth century began the era of scientifically based recommendations on nutrition and pregnancy. The now-classic studies conducted by Bertha Burke at Harvard in the 1940s were particularly influential.[142] These studies showed that diet quality during pregnancy, assessed using diet histories, was strongly related to newborn health status. Newborns assessed as having optimal physical condition by pediatricians were found to be much more common among women consuming high-quality diets, whereas those with the poorest physical condition were born to women with the poorest-quality diets. Average birthweight of newborns assessed as being in optimal physical condition was 7 lb 15 oz in females, and 8 lb 8 oz in males.[143] Although Burke's studies did not show that high-quality pregnancy diets by themselves were responsible for robust newborn health, they provided some of the first evidence that prenatal diet quality may strongly influence pregnancy outcome.

The Need for Energy

Energy requirements during pregnancy increase mainly due to protein and fat tissue synthesis, and the energy cost of maintaining an expanding amount of metabolically active tissues. Protein synthesis primarily occurs in fetal, placental, uterine, and breast tissues. Most of the fat synthesized

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during pregnancy is used to build up maternal fat stores. Expanded metabolic activity related to the increased work of the mother's cardiovascular, respiratory, and renal systems is responsible for much of the increase in energy needed for basal metabolism. The fetus accounts for about a third of the increased energy needs of pregnancy.[21,23]

Energy requirements change during pregnancy depending on the timing of maternal and fetal tissue formation. Figure 4.12 shows the average, estimated calorie requirements for maternal fat and protein tissue synthesis, and for basal metabolism, by time in pregnancy. The increased need for energy in pregnancy averages 300 kcal a day, or a total for pregnancy of 80,000 kcal.[21] The Dietary Reference Intakes (DRIs) for energy intake have been updated in 2023.[144] The estimated energy recommendations (EER) for pregnancy take into consideration four physical activity level (PAL) categories and are based on each woman's age, height, and current weight, as well as weeks of gestation and energy deposition in fetal and maternal tissues. The additional calories for energy deposition are allowed during the second and third trimesters and are 300 kcal/day for underweight women, 200 kcal/day for normal weight women, 150 kcal/day for overweight women, and -50 kcal/day for obese women. The estimated energy recommendations during pregnancy are calculated using the equations in Table 4.18 taking the sum of total energy expenditure (TEE) and energy deposition.[144]

Additional energy requirements of women have been found by different studies to range from 210 to 570 kcal a day.[17] The need for additional calories during pregnancy may be a good deal lower in women who perform little exercise and higher in women who are very active. Low levels of energy expenditure from physical activity are common in the first trimester of pregnancy, and the energy savings may produce a positive caloric balance even though a woman's caloric intake hasn't changed much. Contrary to a previous belief, energy needs of pregnant women do not appear to be affected by "metabolic efficiencies" of pregnancy that decrease caloric need.[145]

Instead, the estimated caloric balance is higher than caloric intake throughout pregnancy and becomes negative postpartum (Figure 4.13). The positive caloric balance observed during pregnancy is due to the fact that women consumed more calories than they expended in physical activity and basal metabolism. Adequacy of calorie intake is most easily assessed in practice by pregnancy weight gain.[146-148] Rates of gain in women who do not have noticeable edema are a good indicator of caloric balance.

Table 4.18 Summary table of EER equations for pregnant women during the second and third trimesters of pregnancy

Life Stage	PAL Category	EER Equation (kcal/day)
2nd and 3rd trimester of pregnancy[a]	Inactive	EER = 1,131.20 − (2.04 × age) + (0.34 × height) + (12.15 × weight) + (9.16 × gestation) + energy deposition
	Low active	EER = 693.35 − (2.04 × age) + (5.73 × height) + (10.20 × weight) + (9.16 × gestation) + energy deposition
	Active	EER = -223.84 − (2.04 × age) + (13.23 × height) + (8.15 × weight) + (9.16 × gestation) + energy deposition
	Very active	EER = −779.72 − (2.04 × age) + (18.45 × height) + (8.73 × weight) + (9.16 × gestation) + energy deposition

Notes: For pregnancy: EER (kcal/d) = TEE (kcal/d) + energy deposition (kcal/d). Energy deposition/mobilization (kcal/d) estimated for underweight (UW), normal weight (NW), overweight (OW), and obese (OB) pregnant women during the 2nd and 3rd trimesters of pregnancy: + 300 kcal/d for UW; + 200 kcal/d for NW; + 150 kcal/d for OW; –50 kcal/d for OB. EERs are in kilocalories/day, age is in years, height is in centimeters, weight is in kilograms, gestation is in weeks, energy deposition is in kilocalories/day.

[a] For the 1st trimester of pregnancy, the nonpregnant TEE prediction equation should be used. It is assumed that energy deposition/mobilization is negligible and therefore ignored.

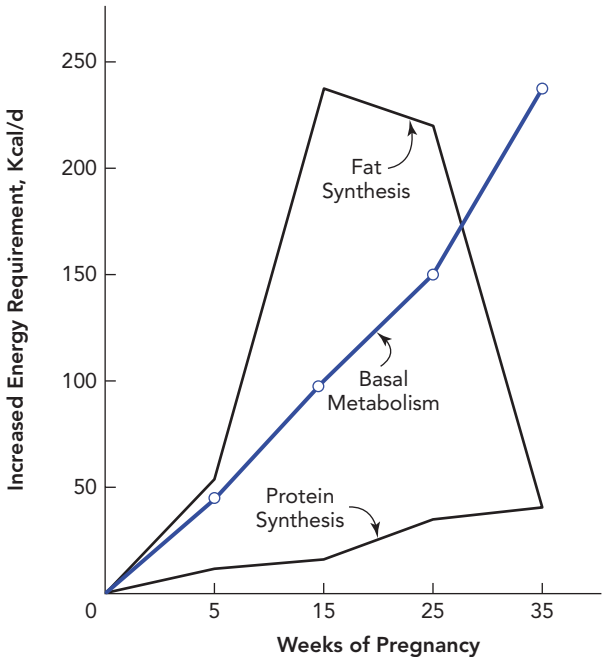


Figure 4.12 Components of increased oxygen consumption in normal pregnancy.

Sources: Graph developed by author from data presented in Durnin, JVGA. (1986). Energy requirements of pregnancy. Nestle Foundation Annual Report, Nestle Foundation, Lausanne, Switzerland:33–38; Hytten, F. E. (1980). Nutrition. In Hytten, F., & Chamberlain, G. (Eds.). *Clinical Physiology in Obstetrics*. Oxford, UK: Blackwell Scientific Publications:163–192; and Institute of Medicine. (1990). *Nutrition During Pregnancy. I. Weight Gain. II. Nutrient Supplements*. Washington, DC: National Academy Press:137–138.

The Need for Carbohydrates As for adults, approximately 45–65 percent of total caloric intake during pregnancy should come from carbohydrates. Women should consume a minimum of 175 g carbohydrates to meet the fetal brain's need for glucose. On average, women in the United States consume 53 percent of calories (269 g) from carbohydrates during pregnancy.[149,150] Basic foods such as vegetables, fruits, and whole-grain products containing

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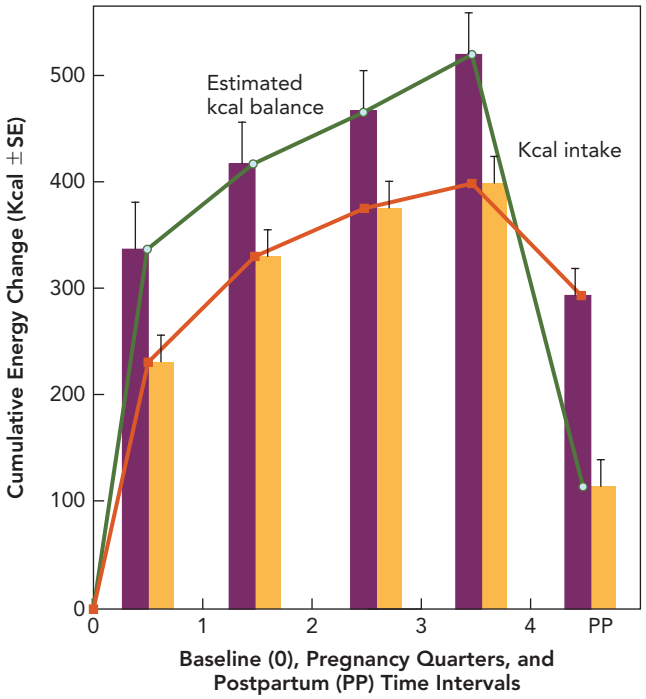


Figure 4.13 Estimated caloric balance in pregnancy through 6–8 weeks' postpartum.

Source: Based on research performed by J. E. Brown, et al. Published in *Clin Perinatol.* 1997; *24*(2):433–449.

fiber and a variety of other nutrients are good choices for high-carbohydrate foods. These foods provide beneficial phytochemicals, such as plant antioxidants, and protection against constipation. In addition, sources of carbohydrates that do not contain added sugars and fat tend to be less energy dense than foods that do and may help women manage pregnancy weight gain.[151]

Artificial Sweeteners Artificial sweeteners were developed as sugar substitutes to help manage blood glucose levels, and to reduce sugar intake, insulin resistance, weight gain, and obesity. Recent evidence indicates that these hoped-for benefits cannot be demonstrated. Regular consumption of artificial sweeteners appears to modify the gut **microbiome** in ways that influence metabolic mechanisms involved in glucose and insulin utilization, and satiety. Regular use of artificial sweeteners has been associated with decreased satiety, altered glucose homeostasis, and increased calorie consumption and weight gain in adults.[152,153]

It now appears that regular intake of artificial sweeteners during pregnancy may have lasting effects on weight status of offspring. Preliminary evidence indicates that infants and children born to women with gestational diabetes who regularly consumed artificially sweetened beverages were more likely to be large-for-gestational age at birth and overweight or obese at age 7 than infants and children born to women with gestational diabetes who did not consume them.[154]

Alcohol and Pregnancy Outcome Most women who drink alcohol stop or decrease drinking when they realize they are pregnant. Some women (less than 10 percent), however, continue to drink during pregnancy or only abstain during part of pregnancy.[155,156]

Alcohol ingested by a pregnant woman readily passes through the placenta to the fetus where it can act as a toxin and interrupt normal growth and development. Adverse effects of high amounts of alcohol intake (such as several drinks per day or more and frequent binge drinking of five or more drinks at a time) include an increased risk of abnormal mental development and growth in the offspring. Adverse effects of alcohol intake during pregnancy are mild or undetectable when intakes are low (such as one or two drinks per week) or when alcohol intake exists but is infrequent.[157,158]

There is no clearly defined safe level of alcohol intake during pregnancy for all women; therefore, it is advised that women who are or may become pregnant do not drink.[157] *In utero* alcohol exposure during the second half of the first trimester of pregnancy is the most critical time for the avoidance of alcohol during pregnancy.[158] Frequent consumption of high amounts of alcohol from early pregnancy onward is related to the development of fetal alcohol spectrum disorders. This topic is addressed in the next chapter.

The Need for Protein

The recommended intake of protein during pregnancy is 71 g daily. On average, pregnant women in the United States consume 73 g of protein daily.[148,150] Physiological adaptations in protein metabolism during pregnancy shift in the direction of meeting maternal and fetal needs for protein. Consequently, less protein is used for energy and more is used for protein synthesis.[150]

Protein requirements increase during pregnancy primarily due to protein tissue accretion. Of the approximately 925 g of protein (2 lb) accumulated in protein tissues during pregnancy, 440 g are taken up by the fetus, 216 g are used for increases in maternal blood and extracellular fluid volume, 166 g are consumed by the uterus, and 100 g are accumulated by the placenta. Additional protein is also required to maintain the protein tissue developed.[159] Protein supplements do not benefit the course or outcome of pregnancy in well-nourished women.[148,160]

Protein content of nonvegetarian diets can be simply estimated by evaluating women's usual daily intake of major sources of protein (Table 4.19).

The Need for Fat

It is estimated that pregnant women consume 33 percent of total calories on average from fat.[150] Fat consumed in foods is used as an energy source for fetal growth and development and serves as a source of fat-soluble vitamins. Fat also provides essential fatty acids that are specifically required for components of fetal growth and development.

microbiome The totality of microorganisms (bacteria, viruses, bacteriophages, and fungi) along with their collective genetic materials present in or on the human body.

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Table 4.19 Tool for estimating protein intake

Food	Protein, Grams	How Much Protein Is There in This Usual Day's Diet?	
Milk, 1 c	8	2 slices toast	6
Cheese, 1 oz	7	1 cup milk	8
Egg, 1	7	3 oz tuna	21
Meat, 1 oz	7	2 slices bread	6
Dried beans, 1 c	13	2 oz chicken	14
Bread, 1 slice or oz	3	1 oz cheese	7
		2 tortillas	6
		½ cup refried beans	7
		Total g protein	= 75

It is recommended that pregnant women consume 13 g of linoleic acid (an essential fatty acid) daily, and 1.4 g of the other essential fatty acid, alpha-linolenic acid. Diets in the United States tend to provide sufficient amounts of linoleic acid, but too little alpha-linolenic acid and other fatty acids related to it.[148] Rich food sources of linoleic acid include safflower, corn, sunflower, and soy oil. Alpha-linolenic acid is found in good quantities in flaxseed, walnut, soybean, canola oils, and leafy green vegetables.

Linoleic acid is the primary fatty acid of the n-6, or the omega-6, fatty acid family, and alpha-linolenic acid is the major n-3, or omega-3, fatty acid. The terms "omega-6" or "omega-3" are assigned to these fatty acids based on the location of the first double bond from the end of the carbon chain of the fatty acid (Figure 4.14). Linoleic acid and alpha-linolenic acid are considered to be long-chained, polyunsaturated fatty acids (LCPUFA) and are sometimes referred to as such.

Linoleic and alpha-linolenic acids serve as structural components of cell membranes. The brain, retina, and other neural tissues of the fetus are particularly rich in these fatty acids. Derivatives of linoleic acid and alpha-linolenic acid serve as precursors for **eicosanoids** that regulate numerous cell and organ functions.[161] Two members of the alpha-linolenic acid family of fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), play particularly important roles in pregnancy. EPA and DHA are highly unsaturated molecules: EPA contains five double bonds between carbons, and DHA has six. The double bonds tend to break down upon exposure to light, heat, or oxygen in the air. They are the components of fish that become oxidized with time and release a "fishy" odor.

eicosanoids Molecules synthesized from essential fatty acids. They exert complex control over many bodily systems, mainly in inflammation and immunity, and act as messengers in the central nervous system.

Omega-3 Fatty Acids, EPA, and DHA During Pregnancy

EPA and DHA can be derived from food sources of alpha-linolenic acid, but only in limited quantities. In pregnant women, 9 percent of alpha-linolenic acid is converted to EPA and DHA.[162] Even relatively high intakes of alpha-linolenic acid during pregnancy fail to increase maternal blood content of EPA and DHA.[163] Consequently, adequate intake of these two omega-3 fatty acids depends on the consumption of food sources of EPA and DHA, or the use of supplements. Fish and seafood are by far the richest food sources of EPA and DHA (Table 1.7 in Chapter 1). Intakes of 500 mg per day of EPA and DHA do not appear to be related to excessive bleeding. Intakes of 500 mg per day are considered safe for consumption by healthy women in pregnancy.[164]

EPA and DHA are selectively transported through the placenta to the fetus and, given adequate maternal intake of these fatty acids, concentrations of EPA and DHA become higher in fetal blood than in maternal blood in the third trimester of pregnancy. Maternal stores of EPA and DHA may become depleted during pregnancy due to their increased use by the developing fetus. Preterm infants may be born with low stores of EPA and DHA.[165]

Eicosanoid derivatives of EPA reduce inflammation, dilate blood vessels, and reduce blood clotting. DHA is a major structural component of phospholipids in cell membranes in the central nervous system, including retinal photoreceptors. It is accumulated into the brain of the fetus most rapidly during the last trimester of pregnancy and during the first year of life.[162] Optimal functioning of the central nervous system appears to depend on the availability of sufficient amounts of DHA during critical phases of growth and development when central nervous system tissues are being formed.[165]

Dietary Intake Recommendations for EPA and DHA

An adequate intake of EPA and DHA during pregnancy is estimated to be 300 mg per day.[166] Most women in the United States consume about a third of this amount.[150] The Food and Drug Administration recommends that intake of EPA and DHA does not exceed 3 g per day.

Due to the benefits to fetal and infant growth and development of adequate DHA and EPA, it is recommended that

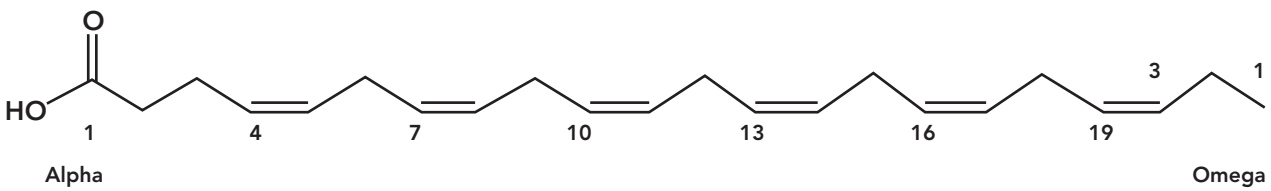


Figure 4.14 The structure of the omega-3 fatty acid DHA, showing the "alpha" end on the left and the "omega" end on the right.

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ADVICE ABOUT EATING FISH

For Those Who Might Become or Are Pregnant or Breastfeeding and Children Ages 1 – 11 Years

Fish‡ provide key nutrients that support a child's brain development.

Fish are part of a healthy eating pattern and provide key nutrients during pregnancy, breastfeeding, and/or early childhood to support a **child's brain development**:

- Omega-3 (called DHA and EPA) and omega-6 fats
- Iron
- Iodine (during pregnancy)
- Choline

Choline also supports development of the **baby's spinal cord**. Fish provide iron and zinc to support **children's immune systems**. Fish are a source of other nutrients like protein, vitamin B12, vitamin D, and selenium too.



FDA.com

Choose a variety of fish that are lower in mercury.

Best Choices
Good Choices
Choices to Avoid

While it is important to limit mercury in the diets of those who are pregnant or breastfeeding and children, many types of fish are both nutritious and lower in mercury.

This chart can help you choose which fish to eat, and how often to eat them, based on their mercury levels.

What is a serving? As a guide, use the palm of your hand.

Pregnancy and breastfeeding:
1 serving is 4 ounces

Eat 2 to 3 servings a week from the "Best Choices" list
(OR 1 serving from the "Good Choices" list).

Childhood:
On average, a serving is about:

1 ounce at age 1 to 3
2 ounces at age 4 to 7
3 ounces at age 8 to 10
4 ounces at age 11

Eat 2 servings a week from the "Best Choices" list.

Best Choices

Anchovy	Herring	Scallop
Atlantic croaker	Lobster, American and spiny	Shad
Atlantic mackerel	Mullet	Shrimp
Black sea bass	Oyster	Skate
Butterfish	Pacific chub mackerel	Smelt
Catfish	Perch, freshwater and ocean	Sole
Clam	Pickerel	Squid
Cod	Plaice	Tilapia
Crab	Pollock	Trout, freshwater
Crawfish	Salmon	Tuna, canned light (includes skipjack)
Flounder	Sardine	Whitefish
Haddock		Whiting
Hake		

Good Choices

Bluefish	Monkfish	Tilefish (Atlantic Ocean)
Buffalofish	Rockfish	Tuna, albacore/ white tuna, canned and fresh/frozen
Carp	Sablefish	Tuna, yellowfin
Chilean sea bass/ Patagonian toothfish	Sheepshead	Weakfish/seatrout
Grouper	Snapper	White croaker/ Pacific croaker
Halibut	Spanish mackerel	
Mahi mahi/dolphinfish	Striped bass (ocean)	

Choices to Avoid HIGHEST MERCURY LEVELS

King mackerel	Shark	Tilefish (Gulf of Mexico)
Marlin	Swordfish	Tuna, bigeye
Orange roughy		

What about fish caught by family or friends? Check for fish and shellfish advisories to tell you how often you can safely eat those fish. If there is no advisory, eat only one serving and no other fish that week. Some fish caught by family and friends, such as larger carp, catfish, trout and perch, are more likely to have fish advisories due to mercury or other contaminants.

www.FDA.gov/fishadvice
www.EPA.gov/fishadvice

U.S. FOOD & DRUG ADMINISTRATION
EPA United States Environmental Protection Agency

‡ This advice refers to fish and shellfish collectively as "fish" / Advice revised October 2021

Figure 4.15 Advice about eating fish.

Source: Advice about Eating Fish. For those who might become pregnant, are pregnant, are breastfeeding, and for children ages 1–11 years. Available at https://www.epa.gov/fish-tech/epa-fda-advice-about-eating-fish-and-shellfish.

pregnant women consume two-to-three servings of cooked fish or seafood each week.[167] Women are encouraged to select different types of fish and seafood low in mercury such as shrimp, canned light tuna, salmon, pollock, and catfish (Figure 4.15). Fish known to generally contain high levels of mercury (swordfish, king mackerel, tilefish, and shark) should not be consumed. The Environmental Protection Agency (EPA) provides information on the safety of locally caught fish on its "EPA Fish Advisory" website.[167]

Many pregnant women avoid eating fish during pregnancy due to a concern that its content of mercury and other pollutants may harm the baby. Intake of low-mercury fish,

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however, has not been related to adverse outcomes.[168] For women who do not like fish or seafood, DHA can be consumed from eggs, DHA-fortified eggs, juices, milk products, snack bars, and other foods labeled as "Fortified with DHA."

Although adequate intake of the omega-3 fatty acids from foods is recommended, supplementation is not. It does not appear that supplemental intakes of DHA or EPA during pregnancy or infancy significantly improve cognitive or neural development in children.[168,169]

The Need for Vitamins and Minerals During Pregnancy

Requirements for most vitamins and minerals increase during pregnancy due to metabolic demands associated with placental and fetal growth, expansion of maternal tissues and plasma volume, and increased nutrient needs for tissue maintenance. Maternal physiological adaptations involve changes in vitamin and mineral absorption and utilization that respond to the changing needs for these nutrients by time in pregnancy.[17]

Folate Inadequate folate during pregnancy has long been associated with anemia in pregnancy and reduced fetal growth.[170,171] Only during the last few decades, however, has the broad spectrum of effects of folate been recognized. Discoveries of the multiple effects of inadequate folate intake on the development of congenital abnormalities and clinical complications of pregnancy represent some of the most important advances in our knowledge about nutrition and pregnancy.

Folate Background The term *folate* encompasses all compounds that have the properties of folic acid and includes monoglutamate and polyglutamate forms of the vitamin. The monoglutamate form of folate is represented primarily by folic acid, a synthetic form of folate used in fortified foods and supplements. A similar monoglutamate form of folate naturally occurs in a few foods. Food sources of folate contain primarily the polyglutamate form of folate. The two major types of folates are often distinguished by referring to the monoglutamates as folic acid and the polyglutamates as dietary folate.

Bioavailability of folic acid and dietary folate differs substantially. Folic acid is nearly 100 percent bioavailable if taken in a supplement on an empty stomach, and 85 percent bioavailable if consumed with food or in fortified foods. Naturally occurring folates are 50 percent bioavailable on average.[172] Folate requirements increase dramatically during pregnancy due to the extensive organ and tissue growth that takes place.

Functions of Folate Folate is a methyl group (CH_3) donor and enzyme cofactor in metabolic reactions involved in the replication of DNA, gene expression, and amino acid metabolism. Deficiency of folate impairs these processes, leading to abnormal cell division and tissue formation. Folate serves as a methyl donor in the conversion of homocysteine to the amino acid methionine. The conversion of homocysteine to methionine depends primarily on three enzymes and folate, vitamin B_{12}, and vitamin B_6 cofactors. Lack of folate in particular, and less commonly of vitamin B_{12}, as well as differences in functional levels of genes that affect folate metabolism can lead to an accumulation of homocysteine. This may result in methionine shortage at a crucial stage of fetal development.[173]

A common gene variant that codes the formation of the enzyme 5,10-methylene tetrahydrofolate reductase (MTHFR) has been identified. This gene variant (MTHFR C677T) is associated with a reduction in blood folate concentration and is found in 1.2 percent of non-Hispanic Blacks, 11.6 percent of non-Hispanic Whites, and 19.4 percent of Hispanic Americans.[174] Up to 60 percent of the U.S. population may experience decreased folate status due to gene variants that affect the activity of MTHFR to some degree.[175] The prevalence of gene variants affecting folate metabolism varies within countries and among population groups.

Folate and Congenital Abnormalities Researchers have known since the 1950s that low and high intakes of certain vitamins and minerals cause congenital abnormalities in laboratory animals. They have also known that neural-tube defects, brain and heart defects, and cleft palate can be caused by feeding pregnant rats folate-deficient diets.[176] Firmly held beliefs that only severe malnutrition affects fetal growth and that genetic errors are the sole cause of congenital abnormalities delayed recognition of the importance of folate to human pregnancy.[170]

Neural-tube defects (NTDs) are malformations of the spinal cord and brain. There are three major types of NTDs:

1. Spina bifida is marked by the spinal cord failing to close, leaving a gap where spinal fluid collects during pregnancy (see Photo 4.4). Paralysis below the gap in the spinal cord occurs in severe cases.
2. Anencephaly is the absence of the brain or spinal cord.
3. Encephalocele is characterized by the protrusion of the brain through the skull.



Biophoto Associates/Science Source

Photo 4.4 A newborn child with spina bifida.

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It is now well accepted that inadequate availability of folate between 21 and 27 days after conception (when the embryo is only 2–3 mm in length) can interrupt normal cell differentiation and cause NTDs.[177] Neural-tube defects are among the most common types of congenital abnormalities identified in infants, with approximately 4,000 pregnancies affected each year in the United States.[178] NTDs are among the most preventable types of congenital abnormalities that exist.[179]

Preliminary evidence indicates that presence of the MTHFR variant in pregnant women may increase the risk of autism.[180] Other risk factors for neural-tube defects exist. Women who are obese or who have diabetes during pregnancy are also associated with development of these defects.[181]

Folate Status of Women in the United States Folate status is assessed by serum and red cell folate levels. Of the two measures, red cell folate levels are the preferred indicator because they represent long-term folate intake, whereas serum folate levels reflect only recent intake. Levels of red cell folate of over 300 ng/mL (or 680 nmol/L) are associated with very low risk of NTDs.[182,183] These levels of red cell folate can generally be achieved by folic acid intakes that average 400 mcg daily. Red cell folate levels are higher among women who consume folic-acid-fortified cereals or supplements compared to women consuming folate from food only (Figure 4.16).

Folate status in women of childbearing age in the United States has improved since the advent of folic-acid fortification of refined grain products in 1998. Average levels of red cell folate in U.S. women have increased 150 percent since fortification began.[183] Countries fortifying foods with folic acid have experienced a 20–80 percent decline in rates of neural-tube defects.[184] Low levels of intake of folic-acid-fortified grain products and breakfast cereals still leave some women with too little folate, however.

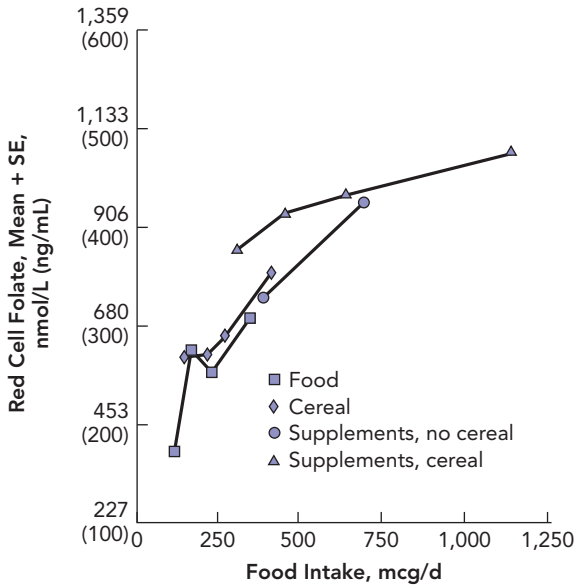


Figure 4.16 Mean red cell folate level in preconceptional women by level of intake of various sources of folate.[182]
Source: Brown, J. E., et al. *JAMA*. 1997; 277(6):551.

Table 4.20 Examples of food sources of highly available folate

	Amount	Folic Acid (mcg)
A. Foods		
Orange	1	40
Orange juice	6 oz	82
Pineapple juice	6 oz	44
Papaya juice	6 oz	40
Dried beans	½ cup	50
B. Fortified Foods		
Highly fortified breakfast cereal[a]	1 cup or 1 oz	400
Breakfast cereal	1 cup or 1 oz	100
Bread, roll	1 slice or 1 oz	40
Pasta	½ cup	30
Rice	½ cup	30

[a]Includes Product 19, Smart Start, Special K, and Total.

Dietary Sources of Folate Many vegetables and fruits are good sources of folate (see Table 1.9 in Chapter 1), but only a few foods contain the highly bioavailable form of folate (Table 4.20). Adequacy of folic acid intake before and during pregnancy can be estimated by adding up the amount of folic acid in foods typically consumed in the daily diet using the data in the table. Whole-grain products including breads and pastas, corn flour, corn tortillas, brown rice, oatmeal, shredded wheat, and organic grain products may or may not be fortified with folic acid. You have to check food labels to find that out.

Recommended Intake of Folate Due to variation in folate bioavailability, the DRI for folate takes into consideration a measure called *dietary folate equivalents*, or DFE. One DFE equals any of the following:

- 1 mcg food folate
- 0.6 mcg folic acid consumed in fortified foods or a supplement taken with food
- 0.5 mcg of folic acid taken as a supplement on an empty stomach

Folic acid taken in a supplement without food provides twice the dietary folate equivalents as does an equivalent amount of folate from food.

It is recommended that women consume 600 mcg DFE of folate per day during pregnancy and include 400 mcg folic acid from fortified foods or supplements. The remaining 200 mcg DFE should be obtained from vegetables and fruits. These nutrient-dense foods provide an average of 40 mcg of folate per serving.[178] Because NTDs develop before women may realize they are pregnant, adequate folate should be consumed several months prior to, as well as throughout, pregnancy.

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It is currently recommended that women take a 400-mcg folic acid supplement prior to and during pregnancy for protection against neural tube defects.[185] Use of higher doses are no longer deemed advantageous. Adequate folic acid is likely being obtained from folic acid–fortified foods and excess folic acid may lead to the availability of excess methyl donors and resulting epigenetic changes in the fetus that may be harmful.[186,187] The upper limit for intake of folic acid from fortified foods and supplements is set at 1,000 mcg per day. There is no upper limit for folate consumed in its naturally occurring form in foods. The 1,000-mcg level represents an amount of folic acid that may mask the neurological signs of vitamin B_{12} deficiency. If left untreated, vitamin B_{12} deficiency leads to irreversible neurological damage.[178]

Choline Choline is a vitamin-like essential nutrient that humans can produce, but not in high enough amounts to meet needs when dietary intake of choline is very limited. The need for choline increases during pregnancy due to its roles as a component of phosopholipids in cell membranes and a precursor of intracellular messengers. Choline can be converted to betaine, which, like folate, serves as a source of methyl groups used to regulate gene function, neural-tube and brain development, and the conversion of homocysteine to methionine.[186] Large amounts of choline are transported via the mother's blood to the embryo and fetus during pregnancy.[188]

The AI for choline in pregnancy is 450 mg daily. Average intake of choline by women between the ages of 20 and 39 years in the United States, however, is 280 mg per day.[150] Some experts are concerned that pregnant women may not be getting enough choline for optimal fetal brain growth and intellectual development.[189] Although this is a much discussed and exciting area of research, it is not yet clear whether low dietary choline availability in women during pregnancy represents a risk factor for fetal brain and intellectual development, or if supplemental choline is beneficial.[187-190] Choline status tends to be adequate in women who regularly consume eggs and meat, the two major sources of this vitamin.[188] The top food sources of choline are listed in Table 4.21.

Table 4.21 The ten top food sources of choline

	Choline, mg
Egg, large	126
Beef, meat only, 3 oz	111
Pork chop, 3 oz	94
Lamb, roasted, 3 oz	89
Ham, 3 oz	87
Turkey, 3 oz	70
Salmon, 3 oz	56
Baked beans, ½ cup	50
Navy beans, boiled, ½ cup	41
Milk, 2%, 1 cup	40

Source: www.ars.usda.gov/nutrientdata.

Vitamin A Vitamin A is a key nutrient in pregnancy because it plays important roles in reactions involved in cell differentiation. Deficiency of this vitamin is rare in pregnant women in industrialized countries, but it is a major problem in many developing nations. Vitamin A deficiency that occurs early in pregnancy can produce malformations of the fetal lungs, urinary tract, and heart.[191,192]

Of more concern than vitamin A deficiency in the United States are problems associated with excessive intakes of vitamin A in the form of retinol or retinoic acid (but not beta-carotene).[193] Intakes of these forms of vitamin A of over 10,000 IU per day, and the use of medications such as Accutane and Retin-A for acne and wrinkle treatment, increase the risk of fetal abnormalities. Effects are particularly striking in infants born to women using Accutane or Retin-A early in pregnancy (see Figure 4.17). Fetal exposure to the high doses of retinoic acid in these drugs tends to result in "retinoic acid syndrome." Features of this syndrome include small ears or no ears, abnormal or missing ear canals, brain malformation, and heart defects.[194]

Due to the potential toxicity of retinol, it is recommended that women take no more than 5,000 IU of vitamin A as retinol from supplements during pregnancy.[36] Most supplements made today contain beta-carotene rather than retinol. High intakes of beta-carotene have not been related to birth defects.[195] Although women were issued strong warnings not to take Retin-A or Accutane if pregnancy was possible, ill-timed use continued to occur, as it did with retinoic acid.[193] Accutane is no longer on the market, but other retinoic acid–based medications for acne remain available but should not be used if conception is possible.[196]

Vitamin D Vitamin D supports fetal growth, the addition of calcium to bone, and tooth and enamel formation. Lack of a sufficient supply of vitamin D during pregnancy compromises fetal as well as childhood bone development.[197] Lack of maternal vitamin D readily compromises fetal vitamin D status.[79,198]

Infants born to women with vitamin D deficiency tend to be smaller than average, more likely to have low blood calcium levels (hypocalcaemia) at birth, and more likely to have poorly calcified bones and abnormal enamel. They are also more likely to develop dental caries in childhood.[199,200] Miscarriage; preeclampsia; preterm birth; maternal infection; and the development of obesity, type 1 diabetes, and asthma in children are under investigation because they appear to be related to maternal vitamin D deficiency.[79,201–205]

Prevalence of Vitamin D Inadequacy Vitamin D inadequacy during pregnancy is common. A study of 206 pregnant women in Toronto found vitamin D deficiency in 35 percent.[200] Of 400 women tested in Pittsburgh, vitamin D deficiency or insufficiency was identified in 83 percent of non-Hispanic Black pregnant women and 47 percent of non-Hispanic White pregnant women. These high rates of inadequate vitamin D status during pregnancy were mirrored in the vitamin D status of infants.[79,206,207] Gene variants that

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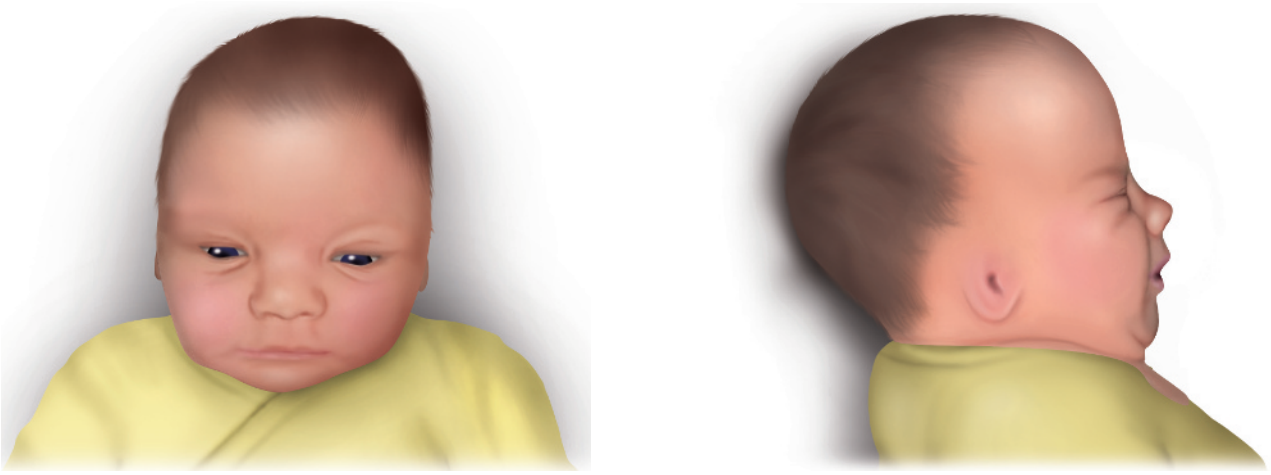


Figure 4.17 An 8-month-old infant exposed to high levels of retinoic acid *in utero*. Note the high forehead, flat nasal bridge, and malformed ear.

Source: Used by permission of Harcourt Health Sciences, Inc. Lott, I. T. et al., Fetal hydrocephalus and ear abnormalities associated with maternal use of isotretinoin, J Pediatr 1984; 105(4):597–600.

affect vitamin D metabolism may be related to variations in vitamin D status in different racial and ethnic groups.[205]

Women with obesity appear to be at increased risk for inadequate vitamin D status due to low levels of release of stored vitamin D from fat cells. As many as 61 percent of obese women have been identified as having low serum levels of vitamin D compared to approximately 36 percent in women who are not obese.[207,208] Vegan women are at risk for poor vitamin D status because vitamin D is naturally present only in animal products (Table 4.22).

Recommendations for Vitamin D Intake During Pregnancy A daily intake of 15 mcg (600 IU) of vitamin D from food is officially recommended for pregnancy. (Note: There are 40 mcg of vitamin D in 1 IU vitamin D.) This amount of vitamin D can be obtained by consuming 3 cups of vitamin D–fortified milk a day, or by exposing the skin to sunshine. Two 15-minute sunbathing sessions per week lead to the production of about 1,250 mcg (50,000 IU) vitamin D and a low risk of sunburn in most light-skinned people. Individuals with dark skin need two to five times this length of sun exposure to produce that much vitamin D and are at a higher risk of vitamin D deficiency. Winter sunlight in northern climates is too weak to produce vitamin D formation in the skin. There is no evidence that vitamin D overdose occurs due to sun exposure.[79,209]

Several experts have found that more vitamin D than 15 mcg (600 IU) daily during pregnancy is needed to treat vitamin D deficiency.[79,204] It may take 2,000 IU (50 mcg) of vitamin D per day during pregnancy to bring vitamin D serum levels up to the normal range in deficient women. One study employed doses of 4,000 IU per day in the second and third trimester of pregnancy and noted positive effects on outcomes and no ill effects related to vitamin D overdose.[210] The upper limit for vitamin D intake in pregnancy is 100 mcg (4,000 IU) per day. The American College of Obstetrics and Gynecology recommends that 1,000–2,000 IU vitamin D be used daily to correct vitamin D deficiency during pregnancy.[79,211] Vitamin D_3 (cholecalciferol) is the preferred form of supplemental vitamin D because it raises serum levels of vitamin D to a greater extent than does vitamin D_2 (ergocalciferol).[212]

Attention should be paid to calcium intake along with vitamin D status. Vitamin D supports the deposition of calcium into fetal bones and a maternal supply of calcium is needed if this is to occur normally. Fetal deposition of calcium in bones represents a critical period during *in utero* development. It is more effective to build fetal bones and ensure an adequate fetal vitamin D status during pregnancy than during the newborn period.[201]

Table 4.22 Risk factors for vitamin D inadequacy during pregnancy

Vegan diet
Consumption of small amounts of vitamin D–fortified milk or of raw milk
Limited exposure of the skin to the direct rays of the sun
Consistent use of sunblock
Dark skin
Obesity

Calcium

Calcium is primarily needed in pregnancy for fetal skeletal mineralization and maintenance of maternal bone health. Approximately 30 g of calcium (a little over an ounce) is transferred from the mother to the fetus during pregnancy. Fetal demand for calcium peaks in the third trimester when fetal bones are mineralizing at a high rate.[213]

Calcium metabolism changes meaningfully during pregnancy. Absorption of calcium from food approximately doubles and excretion of calcium in urine decreases. The additional requirement for calcium in the last quarter of pregnancy is approximately 300 mg per day and is partly obtained by increased absorption and by release of calcium from bone.[213] (Calcium is not taken from the

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teeth, however.[214]) Calcium lost from bones appears to be replaced after pregnancy in women with adequate intakes of calcium and vitamin D.[214]

Calcium needs during pregnancy can be met by drinking 3 cups of milk or calcium-fortified soymilk, or 2 cups of calcium-fortified orange juice plus a cup of milk, or by choosing a sufficient number of other good sources of calcium daily (see Table 1.14).

Fluoride Teeth begin to develop *in utero*, so why isn't it recommended that pregnant women consume sufficient fluoride so that the fetus builds cavity-resistant teeth? A limited amount of fluoride is transferred from the mother's blood to the developing enamel of the fetus. Major gains in the fluoride composition of enamel, however, occur in the years after birth when enamel in primary and permanent teeth fully[216, 217] develops and hardens.[215] Children of pregnant women given fluoride supplements during pregnancy have the same rates of dental caries as do children of women who did not receive supplements.[216]

Iron Iron status is a leading topic of discussion in prenatal nutrition because the need for iron increases substantially;[217] women require about 1,000 mg (1 g) of additional iron for pregnancy:

- 300 mg is used by the fetus and placenta.
- 250 mg is lost at delivery.
- 450 mg is used to increase red blood cell mass.

Maternal iron stores get a boost after delivery when iron liberated during the breakdown of surplus red blood cells is recycled.[218]

Iron Deficiency and Iron Deficiency Anemia These are the most common nutrient deficiency diseases in the world (Table 4.23).[219] Rates of iron deficiency anemia (2.6 percent) and iron deficiency (16.3 percent) in the United States are substantially lower than that of developing countries.[220] They are higher in low-income women served by the WIC program than those not served, averaging 34 percent by the third trimester.[105] The incidence of iron deficiency is higher in women who have had two or more pregnancies.[219]

Iron-Deficiency Anemia in Pregnancy **Iron- deficiency anemia** at the beginning of pregnancy increases the risk of preterm delivery and low-birthweight infants by two to three times.[221,222] It is related to lower scores on intelligence, language, gross motor, and attention tests in affected children at the age of 5 years.[223] The mechanisms underlying these effects appear to be related to decreased oxygen delivery to the placenta and fetus, increased rates of infection, or adverse effects of iron deficiency on brain development. Women with iron-deficiency anemia feel tired and weak, find physical activities difficult, and look pale.[221]

A fetus from a well-nourished mother is able to store a 6- to 8-month supply of iron during the last 2 months *in utero*. Preterm infants are at risk for iron deficiency in infancy because they have less time to accumulate iron in late pregnancy.[223]

Table 4.23 Estimates of the incidence of iron-deficiency anemia in women in developing and developed countries[218,219]

	% with Iron-Deficiency Anemia	
	Developing Countries	Developed Countries
Nonpregnant	30	12
Pregnant	50	18

iron-deficiency anemia A condition often marked by low hemoglobin level. It is characterized by the signs of iron deficiency plus paleness, exhaustion, and a rapid heart rate.

Assessment of Iron Status Red cell mass increases substantially (30 percent) in pregnancy. However, plasma volume expands more (by about 50 percent). The higher increase in plasma volume compared to red cell mass makes it appear that amounts of hemoglobin, ferritin, and red blood cells have decreased. They have not decreased but, rather, have become diluted by the large increase in plasma volume. Hemoglobin concentration normally decreases until the middle of the second trimester and then rises somewhat in the third. It is not necessary to prevent normal declines in hemoglobin level during pregnancy.[223]

Due to the dilution effects of increased plasma volume, changes in hemoglobin levels tend to be more indicative of plasma volume expansion than of iron status.[222] Low levels of hemoglobin or serum ferritin may be associated with high plasma volume expansion (hypervolemia), and high hemoglobin levels are related to low plasma volume expansion (hypovolemia). Low levels of plasma volume expansion are associated with reduced fetal growth, whereas newborns tend to be larger in women with higher levels of plasma volume expansion.[223]

The Centers for Disease Control and Prevention (CDC) has developed standard hemoglobin levels to be used in the identification of iron-deficiency anemia in pregnant women. These standards (Table 4.24) represent levels below the 5th percentile of hemoglobin values in pregnancy.

By trimester, hemoglobin levels indicative of iron-deficiency anemia are:

- Less than 11.0 g/dL in the first and third trimesters
- Less than 10.5 g/dL in the second trimester

Serum ferritin cut-points indicative of iron-deficiency anemia in pregnancy have also been developed:

	Serum Ferritin, ng/mL
Normal	>35
Depleted stores	<20
Iron deficiency	≤15

The diagnosis of iron-deficiency anemia is more complicated than often thought. No single test of iron status is totally accurate because (1) many factors, including

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Table 4.24 CDC's gestational age-specific cutoffs for anemia in pregnancy[223]

Gestational Weeks	Hemoglobin (g/dL) Indicating Anemia[a]
12	<11.0
16	<10.6
20	<10.5
24	<10.5
28	<10.7
32	<11.0
36	<11.4
40	<11.9

[a]For women living in high altitudes, hemoglobin values should be increased by 0.2 g/dL for every 1,000 feet above 3,000 and by 0.3 g/dL for every 1,000 feet above 7,000. For cigarette smokers, hemoglobin values should be adjusted upward by 0.3 g/dL.

infection and inflammation, affect iron status; and (2) each test measures a different aspect of iron status. It is best to base the diagnosis of iron-deficiency anemia on results of several tests.[220] Hemoglobin measurements reflect the presence or absence of iron-deficiency anemia, ferritin targets the level of stored iron, and soluble transferrin receptor assay results reflect tissue iron availability.[220]

Women entering pregnancy with adequate iron stores tend to absorb about 10 percent of total iron ingested; those with low stores absorb more—about 20 percent of the iron consumed. The largest percentage of iron absorption, 40 percent, occurs in women who enter pregnancy with iron-deficiency anemia. Iron absorption from foods and supplements is enhanced in women with low iron stores during pregnancy, and absorption increases as pregnancy progresses.[34] Absorption is highest after the 30th week of pregnancy, when the greatest amount of iron transfer to the fetus occurs. Maternal iron depletion in pregnancy decreases fetal iron stores, increases the risk that infants will develop iron-deficiency anemia, and is associated with development of maternal postpartum depression.[224]

Recommendations for Iron Supplementation in Pregnancy

Recommendations for iron supplementation during pregnancy vary across the globe but generally recommend screening for iron deficiency using several tests to determine the need for iron. This position is held by The American College of Obstetrics and Gynecology.[220] High-dose iron supplements (45 mg/day plus) are no longer recommended for use in pregnancy because they surpass the tolerable upper limit for iron intake, are not associated with health benefits, and because there is evidence of harm from inflammation and gastrointestinal side effects due to the presence of high blood levels of reactive iron.[220] High doses of iron have limited effect on iron status because iron absorption decreases steadily as iron intake increases (Figure 4.18).

Women and their pregnancies benefit more from healthy dietary patterns that include sufficient iron than from attempts to "catch up" on needed iron during pregnancy.

Iodine

Iodine is required in pregnancy by the mother and fetus for thyroid function and energy production, and for fetal brain development.[225] Deficiency of iodine early in pregnancy can lead to **hypothyroidism** in the offspring.

hypothyroidism A condition characterized by growth impairment, intellectual disabilities, and deafness when caused by inadequate maternal intake of iodine during pregnancy. Used to be called *cretinism*.

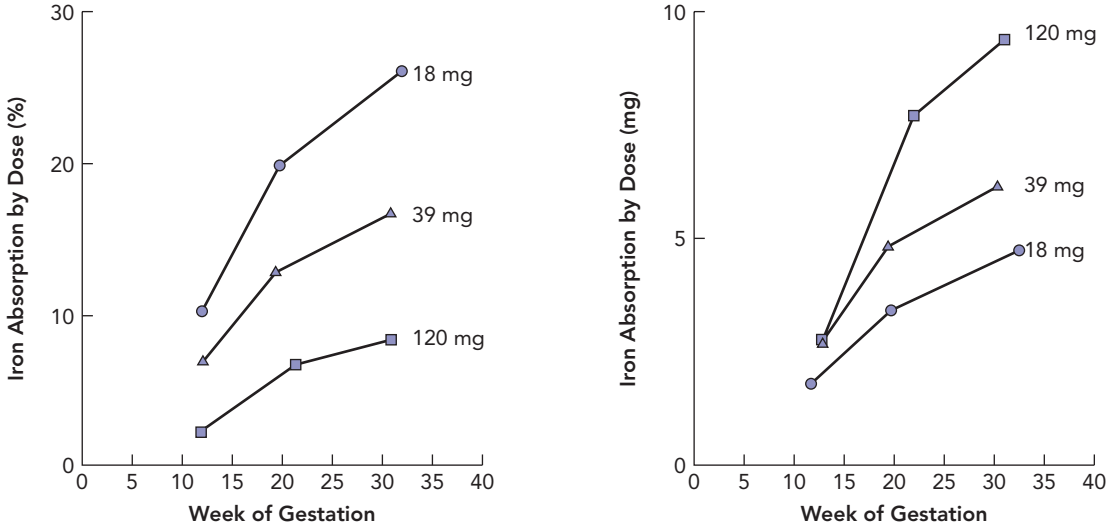


Figure 4.18 Effect of dose of supplemental iron on iron absorption in women during pregnancy.

Sources: Reprinted with permission from *Nutrition During Pregnancy: Part I: Weight Gain, Part II: Nutrient Supplements*, p. 287, Figure 14–2, 1990 by the National Academy of Sciences, Courtesy of the National Academies Press, Washington, DC; Arija, V., Fargas, F., March, G., Abajo, S., Basora, J., Canals, J., Ribot, B., Aparicio, E., Serrat, N., Hernández-Martínez, C., Aranda, N. Adapting iron dose supplementation in pregnancy for greater effectiveness on mother and child health: Protocol of the ECLIPSES randomized clinical trial. *BMC Pregnancy and Childbirth*. 2014 Dec; 14(1):1-0.

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Hypothyroidism in infants is endemic in parts of southern and eastern Europe, Asia, Africa, and Latin America.[226] The incidence of infant hypothyroidism has been found to decrease by over 70 percent when at-risk women in developing countries are given iodine supplements before or in the first half of pregnancy. Rates of infant deaths are also substantially improved, as is the psychomotor development of the offspring.[227] Iodine supplementation in the second half of pregnancy did not improve infant outcomes.[225] Countries instituting iodized salt programs have achieved substantially lower rates of iodine deficiency during pregnancy than before the programs.[227]

About half of pregnant women in the United States consume less than the recommended 220 mcg of iodine daily, and 7 percent have low urinary iodine levels.[228,229] The most reliable source of iodine is iodized salt. One teaspoon contains 400 mcg of iodine. Fish, shellfish, seaweed, and some types of tea provide iodine. Women who consume iodized salt are not likely to need supplemental iodine.[230] Kelp and seaweed should not be used as a source of iodine because they vary too much in iodine content.[231]

Iodine supplements should be used only by women who are at risk of iodine deficiency due to the lack of iodine in the food supply, or because of diagnosed iodine deficiency. Excess blood concentration of iodine interferes with normal thyroid function.[225,226] Usual iodine intake should not exceed 1,100 mcg daily during pregnancy.

Sodium Sodium plays a critical role in maintaining the body's water balance. Requirements for it increase markedly during pregnancy due to plasma volume expansion. But the need for increased amounts of sodium in pregnancy hasn't always been appreciated. Thirty years ago in the United States, it was accepted practice to put all pregnant women on low-sodium diets. It was then thought that sodium increased water retention and blood pressure, and that sodium restriction would prevent edema and high blood pressure. We now know this isn't accurate and that inadequate sodium intake can complicate the course and outcome of pregnancy. Sodium restriction during pregnancy may exhaust sodium conservation mechanisms and lead to excessive sodium loss.[232]

Sodium restriction is not indicated in normal pregnancy or for the control of edema or high blood pressure that develops in pregnancy. Women should be advised to consume salt "to taste" unless contradicted by a medical condition related to salt intake.[233]

Bioactive Components of Food

Foods contain thousands of biologically active substances that are not considered essential nutrients but nonetheless influence health. These food substances are generally referred to as **bioactive food components** and include hundreds of phytochemicals (plant chemicals) that may influence maternal health. Antioxidant pigments in plant foods and caffeine are two primary examples of bioactive food components that have been investigated for effects on maternal and newborn health. Many of the beneficial effects of antioxidant consumption in foods are not found when the antioxidants are taken as supplements, implying that multiple constituents of food rather than isolated nutrients are responsible for health effects.[234]

bioactive food components Constituents in foods or dietary supplements other than those needed to meet basic human nutritional needs that are responsible for changes in health status.

Normal pregnancy is a pro-oxidative state and is accompanied by an increased requirement for antioxidants. Many plant pigments act as antioxidants and help protect fetal DNA from damage due to exposure to oxygen and other oxidizing chemicals produced in the body. Antioxidants also reduce maternal tissue damage associated with inflammation and oxidation. Vitamins C and E (also found in plant foods) likewise perform important antioxidant roles during pregnancy.[234] High intakes during pregnancy of foods rich in vitamin E, for example, appear to reduce the risk of asthma in children. Children born to women consuming diets providing 26 mg of vitamin E daily on average are less likely to develop wheezing and asthma during early childhood than are children born to women who consume 14 mg of vitamin E daily.[235] It is suggested that vitamin E intake from food during pregnancy may reduce asthma by decreasing lung inflammation in the offspring.[236]

Foods rich in antioxidants often advertise that fact by their color. Red, orange, dark green, deep yellow, bright white, and blue-purple fruits and vegetables generally provide good amounts of antioxidants. Many of these same foods are rich in vitamin C. Women who are pregnant should consume at least 5 cups of vegetables and fruits daily.

Coffee/Caffeine Caffeine has long been suspected of causing adverse effects in pregnant women because it increases heart rate and stimulates the central nervous system. It easily passes from maternal to fetal blood and lingers in the fetus longer than in maternal blood because the fetus excretes it more slowly.[237] Coffee is by far the largest contributor to caffeine intake in most people (see Table 2.4 in Chapter 2). Pregnant women consume on average 144 mg of caffeine from coffee per day during pregnancy.[238]

Although it is sometimes recommended that pregnant women not drink coffee during pregnancy or limit intake to 200 mg a day, most recent reports on caffeine intake and health in general indicate benefits of moderate consumption.[130] Some researchers noted that caffeine is believed to cause blood vessels in the uterus and placenta to constrict, which could reduce the blood supply to the fetus and inhibit growth.[239–241]

Research results related to the effects of coffee and caffeine intake on pregnancy outcome indicate that a reappraisal of the 1980 Food and Drug Administration (FDA) recommendation to limit coffee intake during pregnancy would be appropriate. The FDA's position on coffee intake

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during pregnancy was based on animal studies that utilized extremely high doses of caffeine.[239–244]

The Need for Water

The large increase in water need during pregnancy is generally met by increased levels of thirst. On average, women consume about 9 cups of fluid daily during pregnancy.[245] Eight to 12 glasses of water each day is the suggested intake during pregnancy. Women who engage in physical activity in hot and humid climates should drink enough to keep urine light-colored and normal in volume. Water, diluted fruit juice, iced tea, and other unsweetened beverages are good choices for staying hydrated.

4.7 Factors Affecting Dietary Intake During Pregnancy

Several important factors beyond food availability and personal resources influence the type of foods women consume during pregnancy. These factors are important to take into account when working with individual pregnant women or while planning, implementing, and evaluating programs for them.

Effect of Taste and Smell Changes on Dietary Intake During Pregnancy

No inner voice directs women to consume foods that provide needed nutrients during pregnancy. Pregnant women may, however, develop food preferences and aversions due to changes in the sense of taste and smell, and they may experience **pica**.

Changes in the way certain foods taste, and the odor of foods and other substances, affect two out of three women during pregnancy. These changes in taste are known as **dysgeusia**. Common tastes in the mouth are metallic, burnt, salty, and rancid. The changes seem to be more pronounced during the first trimester and are usually benign. If asked to recall, many previously pregnant women could tell you which foods tasted really good to them, and which odors made them feel queasy even to think about. Increased preference for foods such as sweets, fruits, salty foods, and dairy products are common. The smell of meat being cooked, coffee, perfume, cigarette smoke, and gasoline are common nasal offenders and may stimulate episodes of nausea. The biological bases for such changes are not known, but they are suspected of being related to hormonal changes of pregnancy.[246–248]

Pica Classified as an eating disorder, pica affects over half of pregnant women in some locations of the southern part of the United States. It is more common in non-Hispanic Black Americans than in other groups, and it is common enough to be considered a normal behavior in some countries. Historically, one type of pica—**geophagia**—was thought to provide women with additional minerals and to ease gastrointestinal upsets. The cause of pica remains a mystery and beneficial effects from the practice of pica have not been documented.[249]

Nonfood items most commonly craved and consumed by pregnant women with pica include ice or freezer frost (**pagophagia**), laundry starch or cornstarch (**amylophagia**), baking soda and powder, and clay or dirt (geophagia). Women experiencing pica are more likely to be iron deficient than those who don't, and iron-deficiency anemia is especially common among pregnant women who compulsively consume ice or freezer frost.[250,251] It is not clear, however, whether iron deficiency leads to pica or if pica leads to iron deficiency.

Pica does not appear to be related to newborn weight or preterm delivery. It can, however, complicate control of gestational diabetes if starch is eaten, and it has caused lead poisoning, intestinal obstruction, and parasitic infestation of the gastrointestinal tract.[251] Women with amylophagia sometimes accept powdered milk as an alternative to laundry starch or cornstarch, and treating anemia often stops the craving for ice or freezer frost.

Cultural Considerations

People tend to be attached to existing food preferences, many of which may have deep cultural roots. Dietary recommendations will differ, for example, for Native Alaskans accustomed to a diet based on wild game; for Cambodians, Vietnamese, and Somalis who may think no meal is complete without rice; and for lactose-intolerant individuals.

The belief that consumption of certain foods "marks" the baby is common in many cultures. People may think, for example, that a woman who loves mangoes and eats lots of them during pregnancy may have a baby born with a "mango-shaped" birthmark. Some cultures would hold that the baby will also have learned to love mangoes because their mother ate them often while pregnant. Other people believe, for example, that beets and beet juice are good sources of iron (they are not) and will increase consumption of them during pregnancy.

Dietary recommendations that are not consistent with a person's usual dietary practices and beliefs, or that are not viewed as acceptable or even preferred by the woman, are least likely to be effective. For best results, dietary adjustments recommended for each individual pregnant woman should take into account her usual practices and preferences.

pica An eating disorder characterized by the compulsion to eat substances that are not food.

dysgeusia Changes in taste. During pregnancy, changes are thought to be caused by hormonal changes.

geophagia Compulsive consumption of clay or dirt.

pagophagia Compulsive consumption of ice or freezer frost.

amylophagia Compulsive consumption of laundry starch or cornstarch.

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4.8 Healthy Dietary Patterns for Pregnancy

Recent research results clearly support the benefits of healthy dietary patterns (The Healthy Eating Index, Mediterranean Dietary Pattern, the Healthy Vegetarian Pattern, and the DASH Eating Plan) on the course and outcome of pregnancy. These dietary patterns capture the metabolic and health effects of multiple and complex interactions among nutrients and other components of food on health.[138,147,148, 252, 253]

Overall, dietary patterns are considered "healthy":

- Provide adequate amounts of energy, essential nutrients, and fiber
- Have anti-inflammatory properties
- Are associated with a low risk of development of major chronic diseases[130,147,254]

Healthy dietary patterns also support the nutritional needs of pregnant women (Table 4.25). They emphasize the consumption of whole grains and whole grain products, low-fat dairy products, legumes, vegetables, fruits, fish and seafood, poultry, nuts, and vegetable oils.[130]

Adequacy of caloric intake during pregnancy is generally based on the rate of weight gain, but for nutrients it is based on the DRIs (Table 4.26). Nutrient intakes during pregnancy should approximate those given in the DRI table, and food intake should correspond to the types and quantity of foods recommended in MyPlate.gov guidance materials. Food plans produced by MyPlate.gov are based on the selection of food types and amounts that provide adequate amounts of essential nutrients in ways that conform to the recommendations of the 2020–2025 Dietary Guidelines and the RDAs for nutrient intake during pregnancy. They adhere to the general advice given in MyPlate.gov about healthful diets: "Make half your plate vegetables and fruits."

An example of a MyPlate.gov one-day food intake plan is shown for a woman named Matty (Table 4.27). Based on her physical activity level (30–60 minutes per day), her pre-pregnancy weight and height, and the fact that she was in the second trimester of pregnancy, it was calculated that she has a total calorie need of 2,600 calories. Table 4.28 shows recommended amounts of food from the food groups that correspond to various levels of calorie need during pregnancy. Although it is difficult for any one menu to match the preferences and food availability situation of every person, the food plan generated by MyPlate.gov gives women a clear idea of the types and amounts of foods that are recommended for pregnancy.

A good deal of additional information is available from the Moms-to-Be section of the MyPlate.gov website. Information available includes details on the nutrient composition of meal plans generated or for those based on an

Table 4.25 Basics of a good diet for normal pregnancy

Good Pregnancy Diets:
1. Provide sufficient calories to support appropriate rates of weight gain.
2. Adhere to a healthy dietary pattern, including MyPlate food group recommendations.
3. Provide all essential nutrients at recommended levels of intake from the diet.
4. Include 600 mcg folate, of which 400 mcg is folic acid, daily.
5. Provide sufficient dietary fiber (28 g/day).
6. Include 9 cups fluid daily.
7. Include salt "to taste."
8. Exclude alcohol.
9. Are satisfying and enjoyable.

Table 4.26 Recommended dietary allowances and upper limits for pregnant and nonpregnant women with normal BMI aged 19–30 years*

	Pregnant	Nonpregnant	Upper Limit (UL)
Energy, kcal			
2nd trimester	+200**	2,403**	–
3rd trimester	+200**		
Protein, g	71	46	–
Linoleic acid, g	13	12	–
Alpha-linolenic acid, g	1.4	1.1	–
Vitamin A, mcg	770	700	3,000
Vitamin C, mg	85	75	2,000
Vitamin D, mcg[a]	15	15	100
Vitamin E, mg	15	15	1,000[c]
Vitamin K, mcg	90	90	–
Thiamin, mg	1.4	1.1	–
Riboflavin, mg	1.4	1.1	–
Niacin, mg	18	14	35[c]
Vitamin B_6	1.9	1.3	100
Folate, mcg[b]	600	400	1,000[c,d]
Vitamin B_{12}, mcg	2.6	2.4	–
Pantothenic acid, mcg	6	5	–
Biotin, mcg	30	30	–
Choline, g	450	425	3.5
Calcium, mg	1,000	1,000	2,500
Chromium, mcg	30	25	–
Copper, mcg	1,000	900	10,000
Fluoride, mg	3	3	10
Iodine, mcg	220	150	1,100
Iron, mg	27	18	45
Magnesium, mg	350	310	350[c]
Manganese, mg	2	1.8	11
Molybdenum, mcg	50	45	2,000
Phosphorus, mg	700	700	3,500
Selenium, mcg	60	55	400
Zinc, mg	11	8	40

*DRIs for females <19 and <30 years are listed at the end of this text.

**Total calories from energy vary per physical activity level (refer to Table 4.18).

[a]1 mcg = 40 IU vitamin D; DRI applies in the absence of adequate sunlight.

[b]As Dietary Folate Equivalent (DFE). 1 = DFE = 1 mcg food folate = 0.6 mcg folic acid from fortified food or supplement consumed with food = 0.5 mcg of a supplement taken on an empty stomach.

[c]UL applies to intake from supplements or synthetic form only.

[d]Applies to intake of folic acid.

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Table 4.27 A My Plate.gov generated one-day food intake plan for Matty

Calories	Allowance		
Total Calories • Empty Calories*	**2,600 per day** • ≤ 362 per day		
Food Group	**Food Group Amount**	**"What Counts As . . . "**	**Tips**
Grains	**9 Ounce(s) per Day**	**1 Ounce of Grains**	**Tips**
• Whole Grains	• ≥ 4½ oz per day	• 1 slice of bread (1 ounce) • ½ cup cooked pasta, rice, or cereal • 1 oz uncooked pasta or rice • 1 tortilla (6 in. diameter) • 1 pancake (5 in. diameter) • 1 oz ready-to-eat cereal (about 1 cup cereal flakes) See more grain examples	• Eat at least half of all grains as whole grains. • Substitute whole-grain choices for refined grains in breakfast cereals, breads, crackers, rice, and pasta. • Check product labels—Is a grain with "whole" before its name listed first on the ingredients list?
Vegetables	**3½ Cups per Day**	**1 Cup of Vegetables**	**Tips**
• Dark green • Red and orange • Beans and peas • Starchy • Other	• 2½ cups per week • 7 cups per week • 2½ cups per week • 7 cups per week • 5½ cups per week	• 1 cup raw or cooked vegetables • 1 cup 100% vegetable juice • 2 cups leafy salad greens See more vegetable examples	• Include vegetables in meals and in snacks. Fresh, frozen, and canned vegetables all count. • Add dark-green, red, and orange vegetables to main and side dishes. Use dark, leafy greens to make salads. • Beans and peas are a great source of fiber. Add beans or peas to salads, soups, side dishes, or serve as a main dish.
Fruits	**2 Cups per Day**	**1 Cup of Fruit**	**Tips**
		• 1 cup raw or cooked fruit • 1 cup 100% fruit juice • ½ cup dried fruit • See more fruit examples	• Select fresh, frozen, canned, and dried fruit more often than juice; select 100% fruit juice when choosing juice. • Enjoy a wide variety of fruits, and maximize taste and freshness by adapting your choices to what's in season. • Use fruit as snacks, salads, or desserts.
Dairy	**3 Cups per Day**	**1 Cup of Dairy**	**Tips**
		• 1 cup milk • 1 cup fortified soymilk (soy beverage) • 1 cup yogurt • 1½ oz natural cheese (e.g., cheddar) • 2 oz processed cheese (e.g., American) See more dairy examples	• Drink fat-free (skim) or low-fat (1%) milk. • Choose fat-free or low-fat milk or yogurt more often than cheese. • When selecting cheese, choose low-fat or reduced-fat versions.
Protein	**6½ Ounces per Day**	**1 Ounce of Protein**	**Tips**
• Seafood	• 10 oz per week	• 1 oz lean meat, poultry, seafood • 1 egg • 1 Tablespoon peanut butter • ½ oz nuts or seeds • ¼ cup cooked beans or peas See more protein food examples	• Eat a variety of foods from the protein food group each week. • Eat seafood in place of meat or poultry twice a week. • Select lean meat and poultry. Trim or drain fat from meat and remove poultry skin.
Oils	**8 Tsp per Day**	**1 Tsp of Oil**	**Tips**
		• 1 tsp vegetable oil (e.g., canola, corn, olive, soybean) • 1½ tsp mayonnaise • 2 tsp tub margarine • 2 tsp French dressing (see more oil examples)	• Choose soft margarines with zero *trans* fats made from liquid vegetable oil, rather than stick margarine or butter. • Use vegetable oils (olive, canola, corn, soybean, peanut, safflower, sunflower) rather than solid fats (butter, shortening). • Replace solid fats with oils, rather than adding oil to the diet. Oils are a concentrated source of calories, so use oils in small amounts.

*Calories from food components such as added sugars and solid fats that provide little nutritional value. Empty calories are part of total calories.

Source: MyPlate.gov.

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Table 4.28 Recommended amounts of food from the food groups that correspond to various levels of calorie need during pregnancy, and amounts of food in each food group that count as a cup, ounce (oz), or teaspoon (tsp)[a]

Calorie Need	Grains	Vegetables	Fruits	Dairy	Protein Foods	Oils
2,000	6 oz	2½ cup	2 cup	3 cup	5½ oz	6 tsp
2,200	7 oz	3 cup	2 cup	3 cup	6 oz	6 tsp
2,400	8 oz	3 cup	2 cup	3 cup	6½ oz	7 tsp
2,600	9 oz	3½ cup	2 cup	3 cup	6½ oz	8 tsp

Food Group	Equivalents
Grains, 1 oz (make half of your servings whole grain)	1 slice bread ½ cup cooked pasta, cereal, rice 1 tortilla (60)
Vegetables, 1 cup (vary your veggies, choose colourful ones)	1 pancake (50) 1 oz ready-to-eat cereal 1 cup raw or cooked vegetables
Fruit, 1 cup	1 cup 100% vegetable juice 2 cup leafy salad greens 1 cup raw or cooked fruit 1 cup 100% fruit juice ½ cup dried fruit 1 large banana (80–90) 1 large grapefruit, peach, pear, orange, mango 3 medium plums

Source: MyPlate.gov, accessed April 17, 2023.

individual's dietary intake, food sources of nutrients, tips for vegetarian diets, physical activity tips, and a dietary intake tracking system. It can also be used to help plan and implement a weight loss program after pregnancy.

Vegetarian Diets in Pregnancy

Nutrient needs in pregnancy may be met by several types of dietary patterns, including those that omit animal products[130,255] (Table 4.29). Special attention needs to be paid to getting sufficient vitamin B_{12}, vitamin D, and the omega-3 fatty acids because these nutrients are primarily present in animal products.[256–258]

Protein needs are met by vegetarians who regularly consume a variety of plant sources of protein and meet energy needs. In pregnant women who consume no animal products, the variety of plant protein sources needs to include complementary sources of protein daily. Protein sources that complement each other, or provide a complete source of protein, include legumes (such as lentils, chickpeas, black-eyed peas, black beans, and lima beans) and grains (corn, rice, bulgur, and barley, for example). Protein requirements in vegetarians whose main source of protein is cereals and legumes may be 30 percent higher than for nonvegetarians due to the low digestibility of protein in these foods.[256,257]

Table 4.29 Vegetarian food guide adapted for pregnant women[130]

Food Group	Servings per Day	Food Group	Servings per Day
A. Grains	6–11	Cow's milk, 1 cup	
Whole-grain bread, 1 slice		Cheese, 1 oz	
Cooked grains, ½ cup		Yogurt, ½ cup	
Fortified cold cereal, 1 oz		Fortified soymilk, 1 cup	
Fortified cooked cereal, ½ cup		**C. Vegetables**	4
Corn, ½ cup		Cooked vegetables, ½ cup	
Pasta, ½ cup		Raw vegetables, 1 cup	
Tortilla, 1 small		Vegetable juice, ½ cup	
Crackers, 4 small		**D. Fruits**	2
B. Legumes, Nuts, Seeds, Dairy	5–7	Medium-sized fruit, 1	
Dried beans, cooked, ½ cup		Cut-up raw or cooked, ½ cup	
Peas, ½ cup		Fruit juice, ½ cup	
Soy products, ½ cup or 2–3 oz		Dried fruit, ¼ cup	
Soynuts, ¼ cup		**E. Fats, Oils, and Sweets**	2 + depending on caloric need
Nut and seed butter, 2 Tbsp		Mayonnaise, oil, margarine, 1 Tbsp	
Nuts and seeds, ¼ cup		Honey, syrup, jams, jellies, sugar, 1 Tbsp	
Eggs, 1			

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Availability of vegetarian food products in large grocery and organic-food stores has expanded substantially.[258] Vegetarians can select veggie burgers, meat analog entrees, meals-in-a-cup, and frozen desserts from food-store shelves. Fortified juice, soymilks, breakfast cereal, and meat substitutes are available and can contribute substantially to vegetarians' intake of vitamins B_{12} and D and calcium (Table 4.30). DHA derived from algae can be used to provide a source of this omega-3 fatty acid in diets of vegetarian pregnant women who do not consume fish or seafood.[259]

Computerized nutrient analysis of several days of usual food intake may be especially helpful for the evaluation of vegan diets and other special diets that exclude groups of food. Maternal dietary pattern evaluation and assessment of rate of weight gain provide objective information on the quality of the dietary pattern and the adequacy of energy intake, and indicate what types of changes are needed. See Case Study 4.1, Vegan Dietary Patterns During Pregnancy.

Dietary Supplements During Pregnancy

Dietary supplements used by pregnant women primarily consist of vitamins, minerals, and/or herbs. Multivitamin and mineral supplements are often recommended for women who are pregnant in the United States, and many women make the decision to use nutrient and herbal supplements on their own.[260] Some women report feeling reassured by a prescription for a vitamin and mineral supplement and may question the competence of clinicians who don't provide one.[255] However, there is little evidence supporting the safety and effectiveness of many of the dietary supplements available on the market and used by pregnant women. The American College of Obstetrics and Gynecology and the Institute of Medicine do not recommend the routine use of multivitamin and mineral supplements during pregnancy, but rather, recommend they be used if indicated by need.[255]

One way to estimate whether or not a dietary pattern meets nutrient needs for pregnancy is to record foods and food amounts consumed for several days and enter the record into the diet analysis tool available at MyPlate.gov. Nutrient shortages and excesses (if present) can be identified and remedied by modifying food choices to better meet needs.

Herbal Remedies and Pregnancy Herbs are generally regarded by the public and by some health professionals as helpful, safe, and gentle. It is estimated that in the eastern United States, 10 to 45 percent of pregnant women use herbal products during pregnancy. Globally this percentage Is higher ranging from 10 to 74 percent depending on the country.[261] Women may not report use of herbs to their health-care provider based on concerns about the provider's knowledge about herbs or a bias against them.[262] Potential herbal-drug interactions may occur when a prescribing health-care provider is not aware of herbal products the pregnant women may be taking on a regular basis.[261]

The active ingredients of herbal products are often similar to those in medications that may not be approved for use in pregnancy.[263] About one-third of commonly used herbal supplements have been deemed unsafe for use by pregnant women (Table 4.31).[264] Women who use herbs should be provided with respectful counseling about effectiveness and safety, and directed toward reliable sources of information about them.[261,262]

Advice to use herbal remedies during pregnancy appears to be based primarily on their traditional use in different societies. This strategy for assessing the safety of herbs doesn't always work. Some herbs considered safe based on traditional use have been found to produce malformations in animal studies.[265] Others, such as blue cohosh, which was previously thought to safely induce uterine contractions, may increase the risk of heart failure in the baby.[266] Ginseng, one of the most commonly used herb

Table 4.30 Levels of key nutrients in fortified and other vegetarian foods[a]

	Key Nutrients			
	Vitamin B_{12}	**Vitamin D**	**Calcium**	**DHA**
RDA for adults:	2.4 mcg	5 mcg	1,000 mg	300 mg[b]
Rice Dream, 1 cup	1.5 mcg	5 mcg	1,004.32	–
Soy milk, 1 cup	2.6 mcg	3 mcg	300 mg	–
Meat analogs, 1 serv.	0–1.4 mcg	–	–	–
Tofu w/calcium sulfate, ½ cup	–	–	130 mg	–
Fully fortified breakfast cereal, 1 cup	6 mcg	2.5 mcg	1,000 mg	–
Other breakfast cereals, ¾ cup	1.5 mcg	1 mcg	0–100 mg	–
Nutritional yeast, 2 Tbsp	7.8 mcg	–	–	–
Algae, 1 capsule	–	–	–	180 mg
DHA-fortified fruit juice, 1 cup	–	–	–	32 mg
Collard greens, 1 cup	–	–	357	–
Kale, 1 cup	–	–	180	–
Turnip greens, 1 cup	–	–	107	–

[a]Check out product labels for product-specific information on nutrient content.

[b]DRIs for DHA are yet to be established. The figure given in the table is from Harris et al., 2009.[165]

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Case Study 4.1 Vegan Dietary Patterns During Pregnancy

Ms. Lederman, a healthy 32-year-old woman entering her 13th week of pregnancy, asks her doctor for a referral to a dietitian to discuss her vegan diet. She receives the referral, and while making an appointment with the nutrition consulting service, she is asked to record her food intake for 3 days prior to the appointment. Ms. Lederman follows the instructions she was given and carefully completes a 3-day food record. Prior to the appointment, she sends her food record to the dietitian she will be seeing.

During the appointment, the dietitian learns that Ms. Lederman started pregnancy at normal weight, has gained 3 lb so far in pregnancy, has no history of iron or another nutrient deficiency, and is experiencing a normal course of pregnancy. Ms. Lederman has been a vegan since the age of 16, and although she believes it is good for her health, she worries that her baby may not be getting the nutrients she or he needs. Ms. Lederman wears sunscreen whenever she goes outside, so she makes little or no vitamin D in her skin. She makes sure to combine plant sources of protein (usually dried beans and grains), so she'll consume complete sources of protein every day.

Results of the dietary analysis performed by the dietitian showed the following average calorie and nutrient intake levels:

Kcal: 2,237
Protein, g: 71
Linoleic acid (n-6 fatty acids), g: 15.2
Alpha-linolenic acid (n-3 fatty acids), g: 0.54
Vitamin B_{12}, mcg: 2.1
Vitamin D, mcg: 3 (120 IU)
Zinc, mg: 15

Questions

1. Is Ms. Lederman consuming enough protein?
2. Based on the information presented, which nutrients are consumed in amounts that are below the DRI standard for pregnancy?
3. Suggest three types of food Ms. Lederman could consume to bring up her intake of the nutrients identified in question 2.



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Table 4.31 Herbs to avoid in pregnancy[265–267]

Aloe vera	Ergot
Anise	Feverfew
Black cohosh	Ginkgo
Black haw	Ginseng
Blue cohosh	Juniper
Borage	Kava
Buckthorn	Licorice
Comfrey	Pennyroyal
Cotton root	Raspberry leaf
Dandelion leaf	Saw palmetto
Ephedra, ma huang	Senna

in the world, has been found to cause malformations in rat embryos,[255] and ginkgo may promote excessive bleeding.[267] Peppermint tea and ginger root, taken for nausea, appear to be safe.[265] Ginger, given in oral doses of 1 g daily for 4 days, has been found to decrease the severity of nausea and vomiting during pregnancy in a majority of women. Ginger use in this study involving 70 women was not related to complications of pregnancy or poor pregnancy outcomes.[268]

Manufacturers of herbal remedies do not have to prove they are safe for use by pregnant women. However, the FDA stipulates that claims related to pregnancy should not be made for herbal supplements.[264]

***L. monocytogenes*, or listeria** A foodborne bacterial infection that can lead to preterm delivery and stillbirth in pregnant women. Listeria infection is commonly associated with the ingestion of soft cheeses, unpasteurized milk, ready-to-eat deli meats, and hot dogs.

4.9 Food Safety During Pregnancy

Certain foodborne illnesses can be devastating during pregnancy. Increased progesterone levels that normally occur decrease pregnant women's ability to resist infectious diseases, so they are more susceptible to the effects of foodborne infections.[269] One particularly important foodborne illness is caused by ***Listeria monocytogenes***. The placenta does not protect the fetus from listeria infection in the mother. Listeriosis during pregnancy is associated with spontaneous abortion and stillbirth in one-third of fetuses and mild infection in mothers. To prevent this foodborne infection, pregnant women should not eat raw or smoked fish, oysters, unpasteurized or soft cheeses, raw or undercooked meat, or unpasteurized milk. Luncheon meats, hot dogs, and other processed meats should be stored correctly, and foods such as hot dogs heated thoroughly (Figure 4.19).[269]

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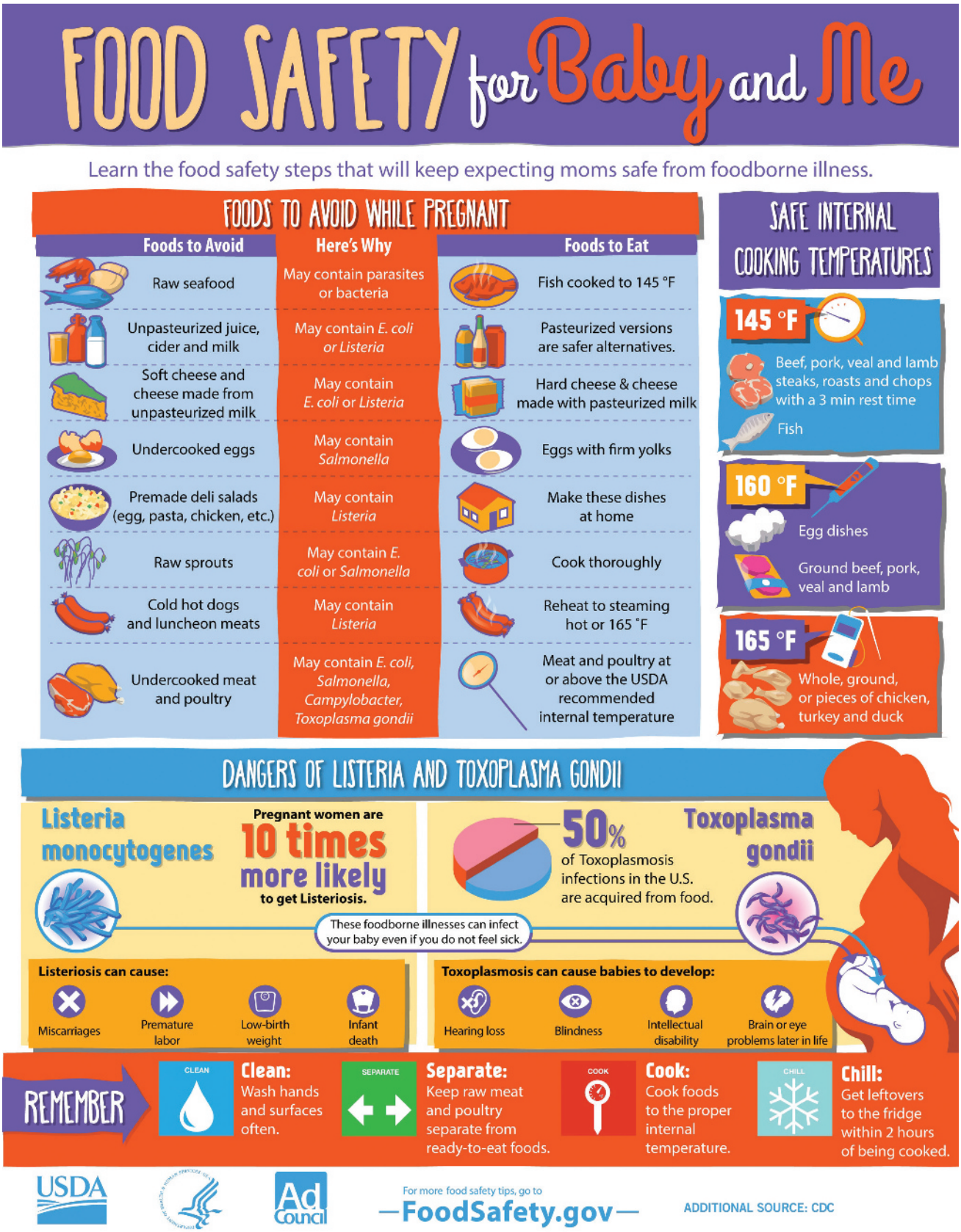


Figure 4.19 Food safety for baby and me.

Source: Food Safety for Baby and Me. Available at https://www.foodsafety.gov/sites/default/files/2019-05/food-safety-infographic-pregnant-women.jpg.

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The protozoan ***Toxoplasma gondii*** also causes serious effects in pregnant women and their fetuses. This protozoan can be transferred from mother to fetus and cause intellectual deficits, blindness, seizures, and death. Sources of *T. gondii* include raw and undercooked meats, the surface of fruits and vegetables, and cat litter. Cats that eat wild animals and undercooked meats can become infected and transfer the infection through the air and via stools left in their litter boxes.[269]

4.10 Assessment of Nutritional Status During Pregnancy

A comprehensive approach to nutrition assessment in pregnancy includes an evaluation of dietary intake, weight status, biomarkers of nutrient status, food preferences and resources, previous pregnancy and health history, and dietary supplement use.[270,271] In this section, we highlight two of these components: assessment of dietary intake and nutrition biomarkers.

Dietary Assessment During Pregnancy

Routine assessment of dietary practices is recommended for all pregnant women to determine the need for an improved dietary pattern. Dietary assessment in pregnancy should cover usual dietary intake, dietary supplement use, and weight-gain progress. For best results, several days of accurately recorded, usual intake should be used for each assessment.

Several levels of dietary assessment can be undertaken. Which assessment level is best primarily depends on the skill level of the health professional responsible for interpreting the results. Results of food-based assessments are rather straightforward to interpret, whereas computerized assessments of levels of nutrient intake are more complex.

Computerized analysis, given accurate records and entry of dietary intake and a high-quality nutrient database, provides results useful for estimating the quantity of calories and nutrients consumed. Detailed knowledge of dietary intake is particularly useful for women with conditions such as gestational diabetes, food intolerances, and multifetal pregnancy.

Nutrition Biomarker Assessment

Nutrition assessment of pregnant women usually includes laboratory tests of iron status, and will include tests to determine the status of other nutrients as indicated. Due to the normal physiological changes occurring during pregnancy, such as hemodilution that affects blood nutrient concentrations, assessment of nutrition biomarkers should employ standards developed for pregnancy.[272] Blood nutrient concentrations change with time during pregnancy, so no one value per nutrient for all of pregnancy accurately reflects status.

Studies reporting reference values for nutrition biomarkers during pregnancy are beginning to appear in the scientific literature (Table 4.32). The concentrations listed by week of gestation consists of values from the 2.5 percentile to the 97.5 percentile of the distribution of values within a sample of well-nourished women with healthy, uncomplicated pregnancies. These values are assumed to reflect normal ranges of nutrition biomarker concentrations during pregnancy and may change as new analysis techniques and data become available. The biomarker levels are intended to assist clinicians in distinguishing between physiological changes and pathological states during pregnancy.[272]

Table 4.32 Reference values for nutrition biomarkers during normal pregnancy in healthy women[a,272]

Nutrient	Weeks' Gestation	Reference Values
Calcium, mmol/L	7–17 24–28 34–38	2.18–2.53 2.04–2.40 2.04–2.41
Chloride, mmol/L	7–17 24–28 34–38	100–107 99–108 97–109
Ferritin, mg/L	7–17 24–28 34–38	7.1–106.4 3.8–49.8 4.8–43.5
Iodine, urinary, mg/L	0–40	150–249
Iron, mmol/L	7–17 24–28 34–38	8.7–37.0 8.0–50.0 7.6–34.5
Magnesium, mmol/L	7–17 24–28 34–38	0.70–0.96 0.63–0.91 0.57–0.87
Potassium, mmol/L	7–17 24–28 34–38	3.24–4.86 3.27–4.62 3.32–5.09
Sodium, mmol/L	7–17 24–28 34–38	133.2–140.5 129.2–139.3 127.0–140.2
Transferrin, g/L	7–17 24–28 34–38	1.92–3.85 2.72–4.36 2.88–5.12
Triglycerides, mmol/L	7–17 24–28 34–38	0.55–3.08 1.09–3.63 1.62–5.12
Vitamin D, nmol/L (25-hydroxyvitamin D)	0–40	≥ 80 (optimum) < 35 (deficient)

[a]See Appendix A for a table of factors used to convert SI units to conventional units. Nutrition biomarkers considered to be in the normal range vary based on percentile cut-points used. The 5th to 95th percentiles are sometimes used and not the 2.5 to 97.5 percentiles reported in this table. Reference values and blood nutrient concentrations considered "normal" or "abnormal" during pregnancy change based on advances in knowledge.

***T. gondii*, or toxoplasmosis** A parasitic infection that can impair fetal brain development. The source of the infection is often hands contaminated with soil or the contents of a cat litter box; or raw or partially cooked pork, lamb, or venison.

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4.11 Exercise and Pregnancy Outcome

Physically active lifestyles during pregnancy are associated with a number of benefits. Moderate intensity exercise (jogging, swimming, cycling, dancing) for 20 minutes daily at the target heart rates shown in Table 4.33 helps:

- Reduce pregnancy discomfort
- Prevent lower back pain
- Shorten labor
- Reduce fat mass gain in mom and fetus
- Prevent gestational diabetes and preeclampsia.[273,274]

Sedentary lifestyles are not associated with these benefits. There are benefits from starting an active lifestyle during pregnancy as well.

It is important to stay hydrated while exercising to prevent dehydration and overheating. It is also important to have the fun that a physically active lifestyle can bring.[63,273,274]

Because pregnant women tend to become "top heavy" in the later part of pregnancy, physical activities that require balance, and those that could cause impacts such as falling or possible contact with hard objects. Women with health concerns or preexisting conditions should check with their health-care provider to make sure exercise is right for them.

4.12 Common Health Problems During Pregnancy

Some of the physiological changes that occur in pregnancy are accompanied by side effects that can dull the bliss of expecting a child by making women feel physically miserable. Common ailments of pregnancy, such as nausea and vomiting, heartburn, and constipation, are generally more amenable to prevention than to treatment, but often can be relieved through dietary measures.

Nausea and Vomiting

Nausea occurs in about 8 of 10 pregnancies, and vomiting in 5 of 10.[275,276] Symptoms of nausea generally begin around week 5 of gestation and generally disappear by week 12. The conditions are so common that they are considered a normal part of pregnancy. In 20 percent of pregnant women, nausea and vomiting continue throughout pregnancy. If not severe or prolonged, the presence of nausea and vomiting during pregnancy is associated with a reduced risk of miscarriage of greater than 60 percent. The causes of nausea and vomiting are not yet clear, but they are thought to be related to increased levels of human chorionic gonadotropin, progesterone, estrogen, and other hormones early in pregnancy.[277]

In the past, the nausea and vomiting of pregnancy was called *morning sickness,* because it was thought to occur mostly after waking up. It actually occurs at all times of day—a mere 17 percent of women experience nausea and vomiting only in the morning.[278] Iron supplements may aggravate nausea and vomiting when taken in the first trimester of pregnancy.[279]

Table 4.33 Target heart rates for healthy pregnant women[285]

Age, Years	Heart Rate
<20	140–155
20–29	135–150
30–39	130–145
40+	125–140

Hyperemesis Gravidarum Between 1 and 2 percent of pregnant women with nausea and vomiting develop *hyperemesis gravidarum* (more commonly called hyperemesis).[280] Hyperemesis is characterized by severe nausea and vomiting that last throughout much of pregnancy. It can be debilitating. In addition to the mother feeling very sick, frequent vomiting can lead to weight loss, electrolyte imbalances, and dehydration. Women with hyperemesis who gain weight normally during pregnancy (about 30 pounds total) are not at increased risk of delivering small infants, but women who gain less (21–22 pounds) are.[281]

Management of Nausea and Vomiting Many approaches to the treatment of nausea and vomiting are used in clinical practice, but only a few are considered safe and effective. Dietary interventions represent a safe method, primarily because the short- and long-term safety of many drugs and herbal remedies early in pregnancy is unclear.[282] Most cases go away after the first trimester.[282] Here are some general recommendations for women experiencing nausea and vomiting:

- Continue to gain weight.
- Separate liquid and solid food intake.
- Avoid odors and foods that trigger nausea.
- Select foods that are well tolerated.

Many women find that hard-boiled eggs, potato chips, popcorn, yogurt, crackers, and other high-carbohydrate foods are well tolerated. Personal support and understanding are important components of counseling women with nausea and vomiting. Care should be taken to individualize dietary advice based on each woman's food preferences and tolerances. Women with hyperemesis may require rehydration therapy to restore fluids and electrolyte balance.[276]

Periodically, articles will appear in the popular press claiming that nausea and vomiting are caused by certain foods, and that women should avoid them to protect their fetus from harmful substances in the foods. Not too long ago it was claimed that bitter-tasting vegetables, for example, should be avoided. When put to the test, this notion was found to be groundless.[283] Theoretical

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claims that certain foods elicit nausea and vomiting in order to protect the fetus from harmful effects of the food should be considered unreliable until proven in scientific studies.

Heartburn

Pregnancy is accompanied by relaxation of gastrointestinal tract muscles. This effect is attributed primarily to progesterone. Relaxation of the muscular valve known as the cardiac or lower esophageal sphincter at the top of the stomach is thought to be the principal reason for the 40–80 percent incidence of heartburn in women during pregnancy. The loose upper valve may allow stomach contents to be pushed back into the esophagus.[277,280]

Management of Heartburn Dietary advice for the prevention and management of heartburn includes:

- Ingest small meals frequently.
- Stop smoking.
- Do not drink carbonated beverages.
- Do not go to bed with a full stomach.
- Avoid foods that seem to make heartburn worse.
- Consume adequate fiber (25–30 g/day).
- Elevate your head and upper body during sleep.[265]

Antacid tablets, which act locally in the stomach, are often recommended in limited amounts, but sodium bicarbonate (baking soda) and heartburn pills usually are not.[263] Although these approaches appear to work for many women, they have not been tested for effectiveness or safety. Approaches to decreasing heartburn should be individualized.[277]

Constipation

Relaxed gastrointestinal muscle tone is thought to be primarily responsible for the increased incidence of constipation and hemorrhoids in pregnancy. One way to prevent these maladies is to consume approximately 30 g of dietary fiber daily. (Table 1.5 in Chapter 1 lists food sources of dietary fiber.) Laxative pills are not recommended for use by pregnant women, but soluble fiber in products such as Metamucil, Citrucel, and Perdiem are considered safe and effective for the prevention and treatment of constipation.[275] Women should drink a cup or more of water along with the fiber supplement.

4.13 Model Nutrition Programs for Risk Reduction in Pregnancy

Fit Moms/Mamás Activas

Postpartum weight retention is a common problem and can increase the risk of chronic disease development. In an attempt to address this situation among WIC participants, a program for an Internet-based weight loss program was developed and implemented. The goal of the program was to determine if an Internet-based programs could produce better postpartum weight loss results than standard WIC clinic services. Fit Moms/Mamás Activas did just that.

Beginning in 2011 and ending in 2015, 371 women attending 12 WIC clinics who were 6 weeks to 12 months' postpartum and had a BMI of over 25 or a BMI of 22–24.9 but exceeded prepregnancy weight by 10.6 lb (4.8 kg) were randomly assigned to the intervention or continued to receive care in WIC clinics. Those in the intervention group received computers if needed (36 percent) and participated in weekly online lessons, a web diary, instructional videos, computerized feedback, text message interactions, and monthly face-to-face groups at WIC clinics. Most women (89 percent) continued participation in the program for a year.

By the end of the year, women in the intervention group had consumed 154 fewer calories per day than those in the control group, and lost significantly more weight than women in the control group (−7 lb/3.2 kg versus 2 lb/1 kg). They were also more likely to have returned to their prepregnancy weight (57 percent versus 36 percent).

The cost of the intervention program was estimated to be $276 per participant, which is likely lower than that for traditional face-to-face weight loss interventions. The cost for similar programs is expected to decrease as more low-income households are able to obtain Internet services.[283,284]

The WIC Program

The WIC program represents an outstanding example of a successful public program intended to serve the nutritional needs of low-income women and families. It is cited as a model program in several other chapters and is described in Chapter 1.

In operation since 1974, WIC provides nutritional assessment, education and counseling, food supplements, and access to health services to over 6 million participants. WIC serves low-income pregnant, postpartum, and breastfeeding women, and children up to 5 years of age who are at nutritional risk. Supplemental food provided to women includes milk, yogurt, fresh vegetables and fruits, whole grain products, ready-to-eat cereals, dried beans, fruit juice, and cheese. Some programs offer vouchers for farmer's markets.[284]

Participation in WIC is related to reduced rates of iron-deficiency anemia in pregnancy, higher-birthweight infants, decreased low-birthweight infants, and lower rates of iron-deficiency anemia in women after delivery. For each dollar invested in WIC, approximately $3 in health-care costs are saved. To find out more about WIC and its history go to nwica.org/overview-and-history. This site has many educational videos and many links to the many services of WIC including how to apply for WIC benefits.

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Key Points

1. Nutritional status before and during pregnancy can modify the health of women during pregnancy, as well as the current and future health of infants.
2. Many aspects of nutritional status, such as dietary intake, supplement use, and weight change, influence the course and outcome of pregnancy.
3. Improved maternal nutrition could help improve the health status of U.S. newborns.
4. A woman's body prepares in advance for upcoming physiological events related to embryonic, placental, and fetal growth and development (such as proliferation of cells in organs and tissues of the placenta and fetus, and rapid increases in fetal weight). Consequently, nutritional needs must be met *prior* to the physiological changes.
5. Functions of the placenta include hormone and enzyme production, nutrient and gas exchange between mother and fetus, and removal of waste products from the fetus.
6. The placenta does *not* block all harmful substances from reaching the fetus.
7. The fetus is not a parasite; it depends on the mother's nutrient intake to meet its nutritional needs.
8. Periods of rapid growth and development of fetal organs and tissues occur during specific times throughout pregnancy. Essential nutrients must be available in required amounts during these times for fetal growth and development to proceed optimally.
9. The risk of heart disease, diabetes, hypertension, and other health problems during adulthood are influenced by maternal nutrition before and during pregnancy.
10. Variations in fetal growth and development are generally *not* due to genetic causes but rather to environmental factors such as energy, nutrient, and oxygen availability, and to conditions that interfere with genetically programmed growth, development, and nutrient utilization.
11. Energy and nutrient availability is considered the major intrauterine environmental factor that alters expression of embryonic and fetal genes. This phenomenon represents the major mechanism that underlies the relationship between maternal nutrition and later disease risk.
12. Pregnancy weight gain affects birthweight and long-term health outcomes. Weight gain recommendations are based on prepregnancy weight status.
13. Excessive weight gain is related to postpartum weight retention and the risk of obesity.
14. High-quality vegetarian and vegan dietary patterns promote a healthy course and outcome of pregnancy.
15. Pregnant women are advised to consume at least 2–3 oz servings of low-mercury fish per week.
16. Caloric adequacy during pregnancy can be estimated by weight gain.
17. MyPlate.gov dietary recommendations for pregnancy are appropriate and recommended for use by pregnant women.
18. Antioxidants and other bioactive compounds in plant foods play key roles in promoting and maintaining maternal and fetal health.
19. Food included in a healthy dietary pattern should provide calories and nutrients needed during pregnancy.
20. In general, exercise is beneficial to the course and outcome of most all pregnancies. Pregnant women in general are encouraged to exercise regularly.
21. Certain foodborne illnesses in pregnant women can threaten fetal survival.
22. Some of the common discomforts of pregnancy, such as nausea and vomiting and constipation, can be ameliorated by nutritional measures.

Review Questions

1. _____ Which of the following statements is incorrect?
   a. Rates of preterm delivery and low birthweight in the United States are trending downward but remain higher in non-Hispanic Black American women and infants than in other groups.
   b. Reductions in the proportion of infants born small, early, or both would clearly decrease infant mortality.
   c. The international ranking of the United States for infant mortality rate has been improving since the beginning of the twenty-first century.
   d. National health objectives for pregnant women and newborns focus on the reduction of low birthweight, preterm delivery, and infant mortality.

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The next four questions pertain to the following case:

Tony was born at 35 weeks of pregnancy and weighed 2,075 g. His waist circumference was low relative to his weight and length. Tony was hospitalized for an infection at 4 months of age.

2. Tony was born preterm.

   _____ True _____ False

3. How much did Tony weigh in pounds and ounces?

   _____ lb _____

4. Tony was proportionately small for gestational age.

   _____ True _____ False

5. Tony was hospitalized during the perinatal period.

   _____ True _____ False

6. Which of the following physiological changes in pregnancy is abnormal?
   a. Plasma volume increases 30 percent
   b. Edema
   c. Increased concentrations of cholesterol, LDL cholesterol, triglycerides, HDL cholesterol
   d. Relaxed gastrointestinal tract muscle tone

7. _____ Which of the following statements about "critical periods" of growth and development is true?
   a. Critical periods are defined as specific time periods early in pregnancy when toxins that may harm fetal growth and development are able to pass through the placenta to the fetus.
   b. It is possible to reverse ill effects of adverse nutrition exposures on fetal growth and development by eliminating the adverse nutritional exposure later.
   c. The most intense period of fetal tissue and organ growth and development is in the third trimester of pregnancy.
   d. Critical periods of growth and development are characterized by hyperplasia, or an increase in cell multiplication.

The next two questions refer to this situation:

Assume a woman with a singleton pregnancy weighed 154 pounds prior to pregnancy and is 5′7″ tall.

8. _____What was her prepregnancy BMI?
   a. 24.1 kg/m^2
   b. 33.2 kg/m^2
   c. 19.7 kg/m^2
   d. 45 kg/m^2

9. _____ What would be the recommended range of total weight for her pregnancy in pounds (lb) and kilograms (kg)?
   a. 28–40 lb, 12.7–18.2 kg
   b. 25–35 lb, 11.4–15.9 kg
   c. 15–20 lb, 6.8–9.1 kg
   d. 22–27 lb, 10–12.3 kg

10. The fetus is able to modify gene functions in response to exposure to adverse conditions that threaten its immediate chances of survival.

    _____ True _____ False

11. Changes in gene functions related to inadequate fetal supply of glucose *in utero* tend to decrease the risk that offspring will become obese in adulthood.

    _____ True _____ False

12. Famine during pregnancy is associated with pSGA at birth and increased risk of heart disease, stroke, and type 2 diabetes in adult offspring.

    _____ True _____ False

13. Exposure to famine during prepregnancy has been repeatedly found to increase the risk of schizophrenia in offspring.

    _____ True _____ False

14. Famine during pregnancy in women who were well nourished prior to pregnancy does not adversely affect pregnancy outcomes.

    _____ True _____ False

15. Iron needs increase during pregnancy primarily due to the loss of iron that occurs with bleeding after delivery.

    _____ True _____ False

16. The need for DHA increases during pregnancy because DHA is a major structural component of phospholipids in cell membranes of the central nervous system.

    _____ True _____ False

17. The need for iron decreases during pregnancy because women do not menstruate during pregnancy.

    _____ True _____ False

18. Meeting vitamin D requirements during pregnancy is particularly important due to the role of vitamin D in fetal bone formation.

    _____ True _____ False

19. The need for folate increases during pregnancy due to its functions as a cofactor in the replication of DNA, gene expression, and amino acid metabolism.

    _____ True _____ False

20. A number of factors influence diet during pregnancy beyond food availability. Which of the following factors does *not* commonly modify dietary intake during pregnancy even when food is easily available?
    a. Culturally based food preferences
    b. Changes in the senses of taste and smell
    c. Lack of appetite
    d. Beliefs about the nutrient content and effects of specific foods on pregnancy outcome

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21. A 1-day diet for a woman in her first trimester of pregnancy who has an estimated need for 2,000 calories a day would include the food group amounts of 6 oz of grain products, 2½ cups of vegetables, 2 cups of fruit, 2 cups of milk, 5 oz of protein foods, and 6 tsp of oil.

    _____ True _____ False

22. _____ Which of the following is not a basic component of a prenatal nutrition assessment?
    a. Evaluation of a 7-day food intake record
    b. Evaluation of biomarkers of nutrient status
    c. Evaluation of dietary intake
    d. Assessment of food preferences and resources

Use the conversion factors listed in the "Conventional Units to SI Units" table in Appendix A to convert the following conventional unit measures to SI units.

23. 52 ng/mL vitamin D (25 hydoxyvitamin D) = _____
24. 86 ng/mL ferritin = _____
25. 402 ng/mL red cell folate = _____
26. Exercise during pregnancy is associated with a lower risk of preterm delivery.

    _____ True _____ False

27. Women who did not exercise prior to pregnancy should not start exercising during pregnancy.

    _____ True _____ False

28. Pregnant women are more susceptible to the effects of foodborne infections in part because decreased progesterone levels decrease resistance to infectious diseases.

    _____ True _____ False

29. Which of the following foods should women *not* consume during pregnancy?
    a. Fish
    b. Broccoli
    c. Raw sprouts
    d. Pasteurized juices
30. One likely effective dietary intervention for women with nausea and vomiting is separation of solid food and liquid food intake.

    _____ True _____ False

31. The frequent ingestion of small meals does *not* appear to help relieve heartburn during pregnancy.

    _____ True _____ False

32. Nutrition programs that tend to improve pregnancy outcomes include the services of nutrition assessment and counseling based on the results of the assessment.

    _____ True _____ False

33. Nutrition programs that tend to improve pregnancy outcomes include the routine provision of a multivitamin and mineral supplement to women.

    _____ True _____ False

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Nutrition During Pregnancy

Conditions and Interventions

Prepared by Judith E. Brown with Ellen Lechtenberg

Learning Objectives

After studying the materials in this chapter, you should be able to:

5.1 Cite three specific examples of nutrition-related recommendations intended for women who enter pregnancy with obesity.

5.2 Distinguish the different types of hypertensive disorders that occur during pregnancy, and connect two components of nutrition care recommended for women with each type.

5.3 Connect the different, major types of disorders in carbohydrate metabolism that occur during pregnancy and the key components of the nutritional management of each type.

5.4 Explain three differences in nutrient needs and cite two specific considerations for delivery of effective nutritional care for women with multifetal pregnancy.

5.5 Identify two primary components of the nutritional care of women with eating disorders during pregnancy.

5.6 Summarize the consequences of excess alcohol intake during pregnancy, and list four factors that affect relationship between alcohol intake and the outcome of pregnancy.

5.7 Distinguish three ways in which energy and nutrient needs differ between adults and adolescents during pregnancy.

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Introduction

Almost all healthy women and birthing people expect that their pregnancies will proceed normally and that they will be rewarded at delivery with a healthy newborn. For the vast majority of pregnancies, this expectation is fulfilled. For other women and birthing people, however, the path to a healthy newborn entails overcoming certain health challenges. This chapter addresses a number of health conditions and the role of nutrition in their etiology and management. The specific conditions consist of person with obesity, hypertensive disorders of pregnancy, diabetes in pregnancy, multifetal pregnancy, eating disorders, fetal alcohol spectrum disorders, and adolescent pregnancy.



Gustoimages/Science Source

Photo 5.1 The magnetic resonance imaging (MRI) on the left shows visceral and subcutaneous fat in an obese woman with a high waist circumference. The image on the right is of a normal weight woman with a normal waist circumference.

5.1 Obesity and Pregnancy

Women and pregnant people who are overweight and obese are often sensitive about their weight and size. Pregnant women who are overweight or obese may suffer increases in distress and anxiety when working with health-care professionals. All women, especially those who fall into this weight category, appreciate factual information presented in a kind, nonjudgmental manner. Women who enter pregnancy with obesity are at higher risk of a number of disorders than are women who are not (Table 5.1). Obesity is associated with an increased risk of gestational diabetes, **preeclempsia**, postpartum hemorrhage, postpartum depression, and preterm delivery.[1,2] Women with obesity are more likely to gain too much weight during pregnancy and to retain the excess weight after delivery.[1,3]

Metabolic effects associated with obesity are closely related to the presence of high amounts of visceral fat (also called intra-abdominal fat). Visceral fat lies beneath skin and muscles of the abdomen, and around internal organs (Photo 5.1). It is much more metabolically active than subcutaneous fat (fat that lies beneath the skin) and is more strongly related to disease risk. Metabolic processes initiated by visceral fat produce chronic inflammation, free-radical generation, and oxidative stress.[4] These disruptions promote the development of insulin resistance, elevated blood glucose, insulin, triglyceride concentrations, and increased blood pressure.[5] These changes, in turn, increase the risk of gestational diabetes, hypertensive disorders, and other clinical conditions during pregnancy.

Normal-weight and overweight individuals with excessive visceral fat deposits are also at increased risk of metabolic abnormalities and diseases associated with them.[4,5]

Children of women with obesity experience a higher risk of becoming obese and developing type 2 diabetes, heart disease, stroke, and asthma.[6-10] Part of the risks associated with obesity are related to gene variants parents transfer to the egg at fertilization and much of the rest to the nutrient supply and other in utero exposures experienced by the rapidly developing embryo and fetus.[8] Embryonic and fetal exposure may include excess blood concentrations of inflammatory markers, oxidative stress, and elevated blood glucose levels.[11] These same exposures and conditions continue to exist and influence health of both mother and child in the future. This effect is demonstrated by the higher rates of obesity, type 2 diabetes, hypertension, and heart disease in women and their offspring later in life.[6,11,12]

preeclampsia A condition that is typically diagnosed after the 20th week of pregnancy. It is characterized by blood pressure readings that exceed 140/90 mm Hg documented on two occasions by blood pressure measurements made at least four hours apart.

Table 5.1 Pregnancy outcomes related to prepregnancy weight status[1,4,19]

Weight Status	Underweight	Normal	Overweight	Obese	Very Obese	Extremely Obese
BMI, kg/m^2	18.5	18.5–24.9	25–29.9	30–34.9	35–39.9	0.40
Preterm	9.2–11.6%	7.1–8.1%	7.5–8.4%	8.4–10.6%	10.3–8.9%	10.3–12.4%
Gestational diabetes	3.5–5.4%	3.8–6.1%	4.7–9.7%	7.0–13.7%	9.6–16.6%	11.0–20.8%
Preexisting diabetes	0%	0.8%	1.7%	2.4%	6.9%	9.7%
Hypertensive disorder	5.8%	9.1%	13.3%	20.7%	23.3%	31.7%
Preeclampsia	2.4%	3.4%	6.4%	10.0%	12.8%	16.3%

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Nutritional Recommendations and Interventions for Obesity During Pregnancy

Women who enter pregnancy with obesity are more likely to gain more weight than recommended during pregnancy compared with normal weight women, and are likely to retain more of the weight gained after pregnancy.[1,13] Nutrition and other health-care services that address weight gain in women with obesity should be provided in the same respectful and nondiscriminatory manner as for other groups of women.[13-15] Weight loss during pregnancy is not recommended due adverse effects on fetal growth and development.[16-18] Many nutrition recommendations for pregnancy in women with obesity, including meeting nutrient needs through consumption of a variety of basic foods, participating in physical activities of choice, and maintaining appropriate rates of weight gain, are the same as those for women of other sizes.[14,19] Intervention programs should be aimed at reducing excessive weight gain among obese women during pregnancy.

There are many success stories of women with obesity who have been able to modify their food choices and exercise pattern, and who have lost weight in preparation for pregnancy, gained the appropriate amount of weight during pregnancy, and successfully lost excess weight after delivery. Others have lowered their disease risk by adopting a regular routine of 30 minutes or more of moderately intense physical activity. These individuals reduce their risk of developing type 2 diabetes, hypertension, heart disease, and other disorders related to the metabolic consequences of obesity.[6,7] Risks are reduced most when healthy dietary patterns and regular exercise are established well before pregnancy.[20]

Weight gained during pregnancy and weight lost after pregnancy (as needed) are best achieved while adhering to a healthy dietary pattern. Healthy dietary patterns are low in sugar and refined carbohydrates, highly processed foods, and red meats; and highlight vegetables, fruits, low-fat dairy products, poultry, fish, and seafood; nuts and seeds, vegetables oils, whole grains, and whole grain products. The dietary pattern developed must be individualized if it is to be acceptable to the client and sustained. Evaluation of the success of the plan agreed upon should be undertaken and mid-course changes made if needed. The same model is useful for the development, implementations, and evaluation of an acceptable exercise program.

Pregnancy After Bariatric Surgery The use of metabolic and bariatric surgery for weight loss continues to increase across the globe. About half of individuals who undergo this surgery are women of childbearing age.[21,22]

Women lose weight rapidly after bariatric surgery due to limited food intake, malabsorption of the macronutrients (especially protein), altered food preferences, increased satiety and decreased appetite, and the presence of **dumping syndrome**, a common side effect of the surgery.[23] Nausea, vomiting, and other symptoms of dumping syndrome may persist into pregnancy. The rapid weight loss and limited food and nutrient intake lead to depletion of tissue stores of many nutrients. Protein intake generally declines substantially after the surgery and rebounds to some extent with time. Deficiencies of vitamins D, B_{12}, folate, and of the minerals zinc and iron are fairly common.[21-25] Chewable forms of vitamin and mineral supplements and monitoring of nutrient biomarkers are routine components of care for individuals undergoing weight-loss surgery. It is recommended that pregnancy be postponed for several years after bariatric surgery, when body weight is stable and nutrient stores have been established.[26]

Maternal and neonatal health outcomes in women who have had bariatric surgery tend to be acceptable as long as adequate maternal nutrition is maintained. Metabolic surgery is bariatric surgery that is performed specifically to address health conditions associated with metabolic syndrome. Addressing diabetes is the main metabolic condition for performing metabolic surgery. Criteria for qualifying for metabolic surgery are often different than the criteria for bariatric surgery for weight loss and include a diagnosis of type 2 diabetes.[27,28] Maternal complications such as **gestational diabetes**, preeclampsia, and large-for-gestational-age newborns are less frequent in obese women who had weight-loss surgery and lost some weight several years before pregnancy compared to women with obesity who did neither.[25,29,30]

Interestingly enough, the beneficial effects of bariatric surgery are independent of weight loss. They depend on changes in metabolic signals that occur in the gastrointestinal tract as a result of the surgery. The search for less invasive therapies that result in these same metabolic benefits is now underway.[23,26,28]

Nutrition Care for Pregnant Women and Pregnant People Post-Bariatric Surgery Nutrition care services are recommended for pregnant women and pregnant people with a history of bariatric surgery. These services should include assessment of dietary intake, supplement use, nutrient biomarker status, weight gain, physical activity, and gastrointestinal symptoms. Nutrition interventions are then implemented as needed to solve nutrition-related problems identified.[31,32]

Nutrient deficiencies and supplementation requirements will vary during pregnancy based on the type of bariatric surgery performed. Roux-en-Y bypass and biliopancreatic diversion surgery severely restrict food intake and are associated with greater weight loss and nutrient deficits than is *lap band* (vertical banded gastroplasty) surgery.[31]

dumping syndrome A condition characterized by weakness, dizziness, flushing, nausea, and palpitation immediately or shortly after eating and produced by abnormally rapid emptying of the stomach, especially in individuals who have had part of the stomach removed.

gestational diabetes Carbohydrate intolerance with onset of, or first recognition in, pregnancy.

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Lap-band surgery involves placement of a band around the top of the stomach. The band limits the size of the stomach and restricts the amount of food that can be consumed. The lap band is sometimes adjusted during pregnancy to help regulate food intake and weight gain.[28] Roux-en Y bypass surgery involves bypassing a portion of the small intestine and reducing the stomach to the size of a walnut. The amount of food consumed is restricted and absorption of calories is limited. The lap-band and Roux-en Y bypass surgeries were popular in the early 2010s, compromising approximately 72 percent of all bariatric surgeries. The most popular bariatric surgery today is the sleeve gastrectomy. In 2019, this surgery compromised approximately 60 percent of all bariatric surgeries performed. In the sleeve gastrectomy surgery, 85 percent of the stomach is removed following a stapling and dividing process. A tube is created, limiting caloric intake.[33]

Women with a history of bariatric surgery generally qualify as "at risk" for gestational diabetes, and blood glucose assessment will be ordered. Many women will experience dumping syndrome if given the 75-g glucose load for blood glucose testing. Alternatives to this test, such as fasting glucose levels or home blood glucose values, should be used instead of the oral glucose load.[21]

5.2 Hypertensive Disorders of Pregnancy

Hypertensive disorders of pregnancy are a leading cause of maternal mortality worldwide. They affect up to 10 percent of pregnancies and contribute significantly to stillbirths, fetal and newborn deaths, and other adverse outcomes of pregnancy. The causes of most cases of hypertension during pregnancy remain unknown, and prevention remains elusive.[34-36] Both environmental factors and inherited genetic variants transferred from mothers and fathers are thought to be involved in the development of preeclampsia.[37] One particular inherited gene variant associated with the metabolic consequences of hypertension has emerged as a possible strong risk factor.[38] A number of other risk factors have been identified and include chronic inflammation, hypertension, chronic kidney disease, polycystic ovary syndrome, obesity, and high maternal age. Many of these conditions are also related to the development of heart disease, stroke, hypertension, type 2 diabetes, and kidney disease.[34] Four types of hypertensive disorders in pregnancy have been identified and are described in Table 5.2.[30, 36, 39]

Hypertensive Disorders of Pregnancy, Oxidative Stress, and Nutrition

All forms of hypertension in pregnancy (as well as other disorders such as diabetes) are related to chronic inflammation, oxidative stress, and damage to the **endothelium** of blood vessels.[40-43] Over time, oxidative stress within the endothelium leads to endothelial dysfunction.

Table 5.2 Definitions and features of hypertensive disorders of pregnancy[30,36,39,43]

Chronic Hypertension Hypertension that is present before pregnancy or diagnosed before 20 weeks of pregnancy. Hypertension is defined as blood pressure 140 mm Hg systolic or 90 mm Hg diastolic blood pressure. Hypertension first diagnosed during pregnancy that does not resolve after pregnancy is also classified as chronic hypertension.
Gestational Hypertension This condition exists when elevated blood pressure levels are detected for the first time after mid-pregnancy (20 weeks). It is not indicated by proteinuria. If blood pressure returns to normal within 10 days' postpartum, the condition is considered to be transient hypertension of pregnancy. If it remains elevated, then the woman is considered to have chronic hypertension. Women with gestational hypertension are at lower risk for poor pregnancy outcomes than are women with preeclampsia.
Preeclampsia A pregnancy-specific syndrome that usually occurs after 20 weeks' gestation (but that may occur earlier) in previously normotensive women. It is determined by increased blood pressure during pregnancy to 140 mm Hg systolic or 90 mm Hg diastolic and proteinuria or end-organ compromise. The disease is highly suspected when increased blood pressure is accompanied by headache, blurred vision, abdominal pain, low platelet count, and abnormal liver enzyme values.
Eclampsia The diagnostic term used when a woman with preeclampsia experiences seizures late in pregnancy that cannot be attributed to another cause.

Consequences of endothelial dysfunction include restriction of placental blood flow, an increased tendency of blood to clot, and plaque formation. Women with hypertensive disorders before conception may benefit from healthy dietary patterns and lifestyles that lower inflammation and oxidative stress (Table 5.3).

Table 5.3 Dietary and other environmental exposures that increase or decrease chronic inflammation and oxidative stress[41]

1. Decrease • Regular intake of colorful fruits and vegetables, dried beans, whole-grain products, olive oil, fish (low mercury), and nuts • Physical activity
2. Increase • Frequent intake of red and processed meats • Frequent consumption of soft drinks, other high-sugar beverages, and refined carbohydrates • Physical inactivity • High levels of body fat, especially visceral fat • Smoking

endothelium The layer of cells lining the inside of blood vessels.

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Chronic Hypertension

The incidence of chronic hypertension—or that diagnosed prior to pregnancy or before 20 weeks after conception—is up to 5 percent and is increasing over time, along with rises in obesity and age of childbearing.[43,44] Most women with chronic hypertension have good pregnancy outcomes. As a group, however, approximately 20 percent will develop preeclampsia versus 4 percent of the general population of pregnant women. Rates of preterm delivery, fetal growth disparity, **placenta abruption**, and Cesarean delivery are higher in women with chronic hypertension than other women.[44-46] The condition is more likely to occur in Black Americans, women with obesity, women over 35 years of age, and women who experienced high blood pressure in a previous pregnancy.[47] Adjustments in the types of antihypertension medications prescribed (such as low-dose aspirin) prior to and during pregnancy are usually made because certain medications interfere with embryonic and fetal growth and development.[41,42]

Nutritional Interventions for Women with Chronic Hypertension in Pregnancy

Preconceptional and eating patterns of pregnant people with hypertension should be carefully monitored with the aim of achieving a healthy eating pattern. Weight-gain recommendations are the same as for other pregnant people. There is no convincing evidence that dietary salt reduction helps prevent or treat hypertension during pregnancy. Consequently, current guidelines do not recommend a sodium restriction during pregnancy to prevent gestational hypertension or the development of preeclampsia.[43,44]

Gestational Hypertension

Gestational hypertension is hypertension that first occurs during pregnancy. Gestational hypertension occurs in 2–3 percent of pregnancies. The effects of gestational hypertension on the course and outcome of pregnancy are often benign. However, women developing gestational hypertension are at increased risk for developing preeclampsia later in pregnancy or during the first week postpartum, and chronic hypertension later in life.[39] Approximately 50 percent of women diagnosed with gestational hypertension before delivery develop preeclampsia.[43] The treatment for gestational hypertension is similar to that for chronic hypertension.

placenta abruption The separation of the placenta from its attachment to the uterus wall before the baby is delivered. Also called abruptio placenta. Consequences of this condition range from mild to severe for the mother and fetus depending on blood loss, extent of fetal distress, gestational age of the fetus, and other factors.

Preeclampsia

Preeclampsia occurs in about 2–8 percent of first pregnancies.[43,47] It represents a syndrome characterized by:

- Oxidative stress, inadequate antioxidant defenses, inflammation, and endothelial dysfunction
- Platelet aggregation and blood coagulation due to deficits in prostacyclin relative to thromboxane
- Blood vessel spasms and constriction, restricted blood flow
- Increased blood pressure
- Insulin resistance
- Adverse maternal immune system responses to the placenta
- Elevated blood levels of triglycerides, free fatty acids, and cholesterol[35,46]

Virtually all maternal organs can be affected in preeclampsia. Organs most affected by small blood clots, vasoconstriction, and reduced blood flow are the placenta and the mother's kidney, liver, and brain. Many of the metabolic abnormalities observed in preeclampsia are present before it is diagnosed and are the same as those for cardiovascular disease.[46] The occurrence of preeclampsia during pregnancy doubles the risk of cardiovascular disease development within 5 to 15 years.[47] Women with preeclampsia are at an increased risk of developing gestational diabetes, type 2 diabetes, and hypertension later in life. About 15 percent of women with gestational diabetes and 30 percent of those with type 2 diabetes prior to pregnancy will develop preeclampsia.[39]

Signs and symptoms of preeclampsia range from mild to severe (Table 5.4), as do the health consequences (Table 5.5). The cause of preeclampsia is unknown but appears to originate from abnormal implantation and vascularization of the placenta, and poor blood flow through the placenta. Abnormal blood flow through the placenta is an important characteristic of preeclampsia because it decreases the delivery of nutrients and gases to the fetus.[35,42,45]

Risk Factors for the Development of Preeclampsia

The roots of preeclampsia lie before and very early in pregnancy, but as yet there is no reliable means of identifying

Table 5.4 Signs and symptoms of preeclampsia[34,36,37]

• Hypertension
• Decreased plasma volume expansion (hemoglobin levels > 13 g/dL)
• Low urine output
• Persistent and severe headaches
• Sensitivity of the eyes to bright light
• Blurred vision
• Abdominal pain
• Nausea
• Shortness of breath, caused by fluid in the lungs

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Table 5.5 Outcomes related to the existence of preeclampsia during pregnancy[39,43,47]

Mother
• Early delivery by Caesarean section
• Acute renal (kidney) dysfunction
• Increased risk of gestational diabetes, hypertension, and type 2 diabetes later in life
• Placenta abruption
• Maternal death
Newborn
• Preterm delivery
• Growth restriction
• Respiratory distress syndrome
• Fetal death

women who will develop it before the condition is established.[42] However, women with insulin resistance, obesity, abnormally high triglyceride levels, or other characteristics listed in Table 5.6 are at increased risk for developing the disease.

Increased rates of preterm delivery and low birthweight in infants born to women with preeclampsia are partly related to clinical decisions to deliver the fetus early in order to treat the disease. Most infants born to women with this disorder are of appropriate weight for gestational age; however, some newborns are large for gestational age (LGA). Variations in birthweight associated with preeclampsia appear to be related to blood pressure levels in individual women.[37]

The risk of developing preeclampsia is higher in women who were born small for gestational age (SGA) than women who were not. It appears that growth restriction *in utero* may impair mechanisms involved in the regulation of blood pressure and increase the probability that high blood pressure will develop with the physiological stresses of pregnancy. The presence of preeclampsia during pregnancy appears to increase the risk of high body mass index, hypertension, and cardiovascular disease in offspring later in life.[35,39,43]

Table 5.6 Risk factors for preeclampsia[42,43,45]

• First pregnancy (nulliparous)
• Obesity, especially high levels of central body fat
• Underweight
• Mother's smallness at birth
• African American, American Indian ancestry
• History of preeclampsia
• Preexisting diabetes mellitus
• Age over 35 years
• Multifetal pregnancy
• Insulin resistance
• Abnormally high blood triglyceride levels
• Chronic hypertension
• Renal disease
• Poor vitamin D status
• Consumption of a pro-inflammatory, pro-oxidative stress diet

Vitamin and Mineral Supplementation and the Risk of Preeclampsia

Oxidative stress and a lack of antioxidant defenses appear to play key roles in the development of preeclampsia. Based on this knowledge, it was theorized that therapeutic doses of vitamins C and E (which function as antioxidants) would decrease oxidative stress and the risk of preeclampsia. Results from early studies suggested that this did happen, but later, better-designed clinical trials failed to identify a true relationship between supplemental vitamin C and E intake and preeclampsia. It is now concluded that vitamin C and E supplements should not be used to prevent preeclampsia.[48] It is also concluded that fish oils, folic acid supplements, magnesium supplements, and garlic are ineffective for the prevention of preeclampsia.[49,50]

It does not appear that vitamin D or calcium supplements are useful for the prevention or management of preeclampsia, with the possible exception of benefits from vitamin D supplementation in women who are vitamin D deficient.[51,52]

Preeclampsia Case Presentation

Signs, symptoms, severity, and causes of preeclampsia vary from woman to woman. Therefore, appropriate interventions for women presenting differing aspects of the syndrome are best designed on a case-by-case basis. Case Study 5.1 describes the course of preeclampsia in one woman experiencing the condition.

Nutritional Recommendations and Interventions for Preeclampsia

In the best of circumstances, dietary interventions for preeclampsia would begin prior to pregnancy. This approach might give women the opportunities to decrease body weight and stores of central body fat, become physically fit, and consume a diet that reduces inflammation and oxidative stress. Short of those circumstances, dietary recommendations and interventions should begin in at-risk women as early in pregnancy as possible.

Nutritional and physical activity recommendations that may benefit women at risk of preeclampsia include:

- Regular intake of colorful vegetables and fruits such as broccoli, beets, carrots, collard greens, kale, strawberries, peaches, and tomatoes
- The frequent inclusion of good sources of fiber, such as dried beans and peas, whole grains, whole grain breads, and cereals
- Water replacement of sugar-sweetened beverages
- Use of low-fat dairy products
- Use of vegetable oils (such as olive oil)
- Selection of poultry, fish, and seafood over processed and red meats

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Case Study 5.1 A Case of Preeclampsia

Ashley is a 19-year-old "meat-and-potatoes" type of eater who rarely consumes vegetables, fruits, or dairy products. She likes monosyllabic vegetables (beans, corn, and peas), bananas and oranges, and chocolate milk. She generally consumes one of these vegetables and fruits each day, and always has a glass of chocolate milk. Ashley consumes sweetened iced tea throughout the day, and twice a week she eats rice with meat rather than potatoes. She finds these types of foods satisfying and rarely consumes foods other than those mentioned.

Her first 17 weeks of pregnancy were uneventful. At week 18, she was found to have proteinuria. By week 22, her blood pressure had increased to 150/100 mm Hg, and she was diagnosed with preeclampsia. Laboratory studies indicated that her blood glucose level was on the high side of normal and that she was insulin resistant. She was left to follow-up after her week 22 visit.

A bit overweight prior to pregnancy, Ashley did not gain weight and restricted her salt intake after midpregnancy. She believed these actions would help lower her weight and blood pressure. Although she was given a supply of prenatal vitamin and mineral supplements early in pregnancy, she rarely remembered to take them. Her baby, weighing 5 lb 5 oz (2,380 g), was delivered by Cesarean section at week 36.

Questions

1. List three ways in which Ashley's eating patterns likely contributed to oxidative stress.
2. Identify two other characteristics of her eating patterns that are contraindicated for women with preeclampsia. Answers should be different than those for question 1.
3. List three health problems Ashley is at increased risk of developing due to her history of preeclampsia.



- Moderate-intensity physical activity (e.g., brisk walking, swimming, tennis, aerobic dancing) for 30 minutes daily unless medically contraindicated
- Weight gain that follows recommendations based on prepregnancy weight status[34,39]

Iron supplements, especially if taken in high doses, may aggravate inflammation by increasing the body's free-radical load. Women with preeclampsia should not be given high-dose iron supplements.[53]

Eclampsia Eclampsia can be a life-threatening condition and one that can be difficult to predict. Eclamptic seizures appear to be related to hypertension, the tendency of blood to clot, and spasms of and damage to blood vessels in the brain. It affects about five to eight of 10,000 pregnancies. The only cure for preeclampsia and eclampsia is delivery of the placenta. Signs and symptoms of preeclampsia and eclampsia generally disappear rapidly after delivery, but they may occur up to 6 weeks' postpartum.[43,46]

5.3 Diabetes in Pregnancy

Diabetes is a leading complication in pregnancy. It has three main forms:

- Gestational diabetes
- Type 2 diabetes
- Type 1 diabetes[54]

There are other less common forms of diabetes,[54] but this section focuses on gestational diabetes, which is first recognized during pregnancy, preexisting type 2 diabetes during pregnancy, and type 1 diabetes (insulin-dependent diabetes).

Due to placental hormones, growth factors, and other physiological changes, pregnancy exerts a *diabetogenic effect* on maternal carbohydrate utilization. Insulin resistance and requirement increase as pregnancy progresses. Maintenance of normal blood glucose levels during pregnancy requires that insulin production by beta cells of the pancreas keep up with the increasing need for insulin. A common thread that ties together the three types of diabetes presented here is the absence or lack of beta cell production of insulin and abnormal blood glucose levels that result. Women with diabetes during pregnancy also share an increased risk of developing high blood pressure and preeclampsia during pregnancy. Excellent control of blood glucose levels throughout pregnancy improves maternal and infant outcomes appreciably. Effective nutrition and lifestyle education during pregnancy benefit the health of women and families long after delivery.[54,55]

Gestational Diabetes

The prevalence of gestational diabetes is estimated to be around 6–9 percent of all pregnancies.[55,56] The incidence increases along with obesity and this affect is pronounced among Asian American women whose dietary patterns and

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lifestyles have become "Westernized."[54,57] Gestational diabetes accounts for 88 percent of all cases of diabetes in pregnancy and is similar in many ways to type 2 diabetes. Women who develop gestational diabetes tend to enter pregnancy with insulin resistance, or a predisposition to insulin resistance, and impaired insulin production, which is expressed due to physiological changes that occur during pregnancy.[55]

Risks Related to Gestational Diabetes Potential consequences of gestational diabetes include an increased risk of spontaneous abortion, stillbirth, **congenital anomalies**, and neonatal death (Table 5.7). High maternal blood glucose levels reach the fetus (Figure 5.1) and cause the fetus to increase insulin production to lower glucose levels. The higher the level of blood glucose received, the larger the fetal output of insulin.[58,59] High insulin levels increase glucose uptake into fetal cells and the conversion of glucose to triglycerides. These changes increase the fetus' synthesis of fat as well as muscle tissue and may program metabolic adaptations that increase the likelihood that insulin resistance, type 2 diabetes, high blood pressure, and obesity will develop later in life. The chances that these disorders will occur increase along with increases in maternal levels of glucose.[60]

Effects of high maternal levels of glucose and triglycerides are particularly striking in the Pima Indians of Arizona. In the Pimas, both obesity and diabetes have become more common during this century, perhaps as a result of rapid cultural and dietary changes in a population genetically susceptible to diabetes. Similar increases in obesity and diabetes appear to be occurring in many other parts of the world. Fetal exposure to poorly controlled maternal diabetes incurs a tenfold increase in the risk that children will develop type 2 diabetes. Offspring of diabetic Pima mothers are heavier at birth, have higher body mass index (BMI) throughout childhood, and have a 7–20 times greater incidence of type 2 diabetes in early adulthood. Although risks of these conditions increase in offspring of women with poorly controlled diabetes in general, the pronounced effect in Pima Indians is likely due to a strong genetic tendency toward insulin resistance and obesity.[61,62]

Loss of the placenta at delivery initially restores insulin sensitivity in most women with gestational diabetes. However, a degree of insulin resistance often remains. Close to half of women with gestational diabetes in a previous pregnancy will develop it in a subsequent pregnancy.[63] Women with gestational diabetes who have high BMIs, those who require insulin for the blood glucose control during pregnancy, and women who gain weight after pregnancy have a seven-fold higher risk of developing type 2 diabetes, as well as high blood pressure later in life.[64,65]

Risk Factors for Gestational Diabetes Both gestational and type 2 diabetes are linked to multiple genetic factors and their environmental triggers, such as excess body fat, unhealthy dietary patterns, and low physical activity levels.[55,66-68] A specific variant of the GIP gene involved in the stimulation of insulin production after a meal has been shown to be related to the development of gestational diabetes. Women with two copies of this variant produce less insulin after a meal than other women.[69] Dietary patterns low in fiber, vegetables, nuts, legumes, whole grains, and other foods represented in healthy dietary patterns, and high in added sugars and processed

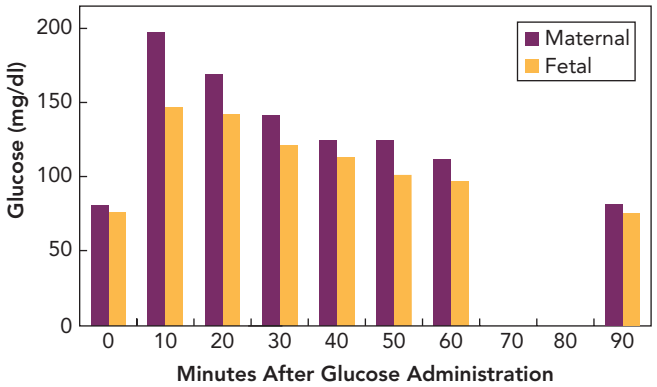


Figure 5.1 Approximate fetal glucose levels following glucose administration to the mother late in pregnancy.
Sources: Graph developed by author from data presented in Walsh, J. M., et al. The association of maternal and fetal glucose homeostasis with fetal adiposity and birthweight. *Eur J Obstet Gynecol Reprod Biol.* 2011; 159:338–341; Parretti, E., et al. Third-trimester maternal glucose levels from diurnal profiles in nondiabetic pregnancies: Correlation with sonographic parameters of fetal growth. *Diabetes Care.* 2001; 24:1319–1323; Freinkel, N., et al. Metabolic realignments in late pregnancy: A clue to diabetogenesis. *Adv Metab Disord.* 1970; 1(suppl 1):205; and Wu, Y., et al. AMP-activated protein kinase mediates effects of oxidative stress on embryo gene expression in a mouse model of diabetic embryopathy. *Diabetologia.* 2012 Jan; 55:245–254.

Table 5.7 Adverse outcomes associated with gestational diabetes[57,58]

Mother
• Caesarean delivery
• Shoulder dystocia
• Increased risk for preeclampsia
• Increased risk of type 2 diabetes, hypertension, and obesity later in life
• Increased risk for gestational diabetes in a subsequent pregnancy
• Hypoglycemia
• Maternal death
Offspring
• Stillbirth
• Spontaneous abortion
• Congenital anomalies
• Macrosomia (10 lb or 4,500 g)
• Neonatal death
• Neonatal hypoglycemia, hypocalcemia, and hyperbilirubinemia
• Increased risk of insulin resistance, type 2 diabetes, high blood pressure, and obesity later in life

congenital anomalies Structural, functional, or metabolic abnormalities present at birth. Also called congenital abnormalities.

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Table 5.8 Risk factors for gestational diabetes[68,72-75]

• Obesity, especially high levels of central body fat
• Weight gain between pregnancies
• Age over 35 years
• Native American, Hispanic, Asian ancestry
• Native American, Hispanic, Asian ancestry
• Genetic traits (GIP variant)
• Strong family history of type 2 diabetes
• History of delivery of a macrosomic newborn (>4,500 g or >10 lb)
• Chronic hypertension
• Mother was SGA at birth
• History of gestational diabetes in a previous pregnancy
• Physical inactivity
• Polycystic ovary syndrome
• Multifetal pregnancy
• Consumption of Western-type diet (low fiber intake, low vegetable and fruit intake, regular intake of sugars and high-glycemic index foods, red and processed meats)

meats are associated with an increased risk of gestational diabetes compared to the risk for women consuming a healthy dietary pattern.[70,71] Risk factors for gestational diabetes are outlined in Table 5.8.[68,72-75]

Diagnosis of Gestational Diabetes The American Diabetes Association (ADA) sets the standards for the diagnosis and management of diabetes and has recently updated and simplified the standards for diabetes in pregnancy.[59] It is recommended that:

1. Fasting and postprandial self-monitoring of blood glucose are recommended in both gestational diabetes mellitus and preexisting diabetes in pregnancy to achieve optimal glucose levels.
2. Routine testing for gestational diabetes be undertaken between 24 to 28 weeks of pregnancy (a critical period for the development of elevated glucose levels in women prone toward diabetes).
3. Women are tested for gestational diabetes using one of two diagnostic approaches:
   - 75 g oral glucose tolerance test, or
   - 50 g non-fasting glucose screen. If positive, follow up with a 100-g glucose tolerance test
4. Acceptable blood glucose concentrations are defined as:
   - Fasting glucose 70–95 mg/dL (3.9–5.3 mmol/L) and either
   - One-hour postprandial glucose 110–140 mg/dL (6.1–7.8 mmol/L) or
   - Two-hour postprandial glucose 100–120 mg/dL (5.6–6.7 mmol/L)

hemoglobin A1c A form of hemoglobin used to identify blood glucose levels over the lifetime of a red blood cell (120 days). Glucose molecules in blood will attach to hemoglobin (and stay attached). The amount of glucose that attaches to hemoglobin is proportional to levels of glucose in the blood. The normal range of hemoglobin A1c is 4–5.9 percent. Also called glycosylated hemoglobin and glycated hemoglobin.

The use of **hemoglobin A1c** for monitoring blood glucose levels is not recommended for diabetes management because the values don't reflect current blood glucose levels.[59,72] Urinary glucose cannot be used to diagnose or monitor gestational diabetes because the results do not accurately reflect blood glucose levels.[59,76]

Management of Gestational Diabetes It is recommended that women with gestational diabetes be provided dietary and exercise counseling as the first-line therapy for gestational diabetes[59] (Table 5.9).

Women with diabetes who are underweight or normal weight are encouraged to gain within the IOM guidelines, and women with obesity are at the low end of their weight-gain ranges.[77] Weight gain during pregnancy is less predictive of birthweight for infants of women with diabetes than other women primarily due to the influence of blood glucose levels on fetal growth.[77]

The oral medication metformin is generally used for the management of blood glucose levels when diet and exercise aren't adequately controlling them.[59] Metformin (glucophage) suppresses glucose production by the liver, increases tissue uptake of glucose, and improves insulin sensitivity. Insulin will be used if needed. Unlike insulin, metformin is transferred to the fetus and increases the risk that newborns will experience hypoglycemia after birth.[59] No two women with gestational diabetes share the same history, risks, needs, and response to treatment (Case Study 5.2).

Exercise Benefits and Recommendations In women with gestational diabetes, insulin resistance and blood glucose levels are decreased by regular aerobic exercise such as brisk walking, jogging, biking, golfing, hiking, swimming, and strength exercises. Exercising on a recumbent

Table 5.9 Comparison of outcomes of unrecognized and diet-treated gestational diabetes[76]

Gestational Diabetes			
Outcome	**Unrecognized**	**Diet-Treated**	**Controls**
LGA (>90th percentile)	44%	9%	5%
Macrosomia (>4,500 g)	44%	15%	8%
Shoulder dystocia	25%	3%	3%
Birth trauma	25%	0%	0%

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Case Study 5.2 Lauren's Story: Gestational Diabetes

Lauren is a 36-year-old who entered pregnancy with a BMI of 23.5 kg/m^2. She began receiving prenatal care at 32 weeks' gestation and was screened for gestational diabetes the next day. Results of her oral glucose tolerance test revealed the following blood glucose levels:

Fasting:	90 mg/dL
1 hour:	195 mg/dL
2 hour:	163 mg/dL

Lauren's health-care provider advised her to consume a "no white food, no-sugar, low-carbohydrate diet" and to keep her weight gain low throughout the rest of pregnancy. She delivered a large infant (4,750 g) at 39 weeks' gestation.

Questions

1. Did Lauren have gestational diabetes?
2. Was she insulin resistant?
3. What's the most likely reason Lauren delivered an abnormally large newborn?
4. What was wrong with the dietary advice Lauren was given?
5. List three components of appropriate dietary advice for women with gestational diabetes.



Sturti/E+/Getty Images

bicycle at a moderately intense pace for 45 minutes three times a week, or performing moderately vigorous activity for 30 minutes/day for 3 days a week from 10 weeks of pregnancy onward help normalized glucose levels in many women.[78,79] Among women with lifestyle controlled gestational diabetes, blood glucose may be monitored less frequently as directed by a health-care provider to make sure they remain in the normal range.[59]

Nutritional Management of Women with Gestational Diabetes Healthy eating patterns practiced before and throughout pregnancy, in general, provide the energy, nutrients, and other beneficial components of foods that support an *in utero* environment for the mother and fetus, and the current and future health of both.[80,81] The dietary pattern recommended for women with gestational diabetes focuses on replacing high-sugar beverages and foods, and refined carbohydrates, with whole grains, vegetables, nuts, and other nutrient-dense, minimally processed foods.[81-86]

Adequate intake of fiber, especially soluble fiber from dried beans, fruits, and vegetables, is particularly encouraged due to beneficial effects on gut microbiota, inflammation, glucose levels, and insulin resistance. The Adequate Intake set for fiber is set at 28 g per day for pregnant people.[87]

Diets are cooperatively planned around a calculated level of caloric need. These initial estimates of caloric need are intended to meet both maternal and fetal need for energy while limiting increases in blood glucose levels. They are based on the pregnant woman's weight status and weight gain goals for pregnancy (Table 5.10). Women's allotment of calories is generally spread across three meals and several snacks.

There is no single distribution of calories from carbohydrate, protein, and fat that works best for blood glucose control in diabetes. The ADA recommends that individuals with diabetes adhere to a calorie distribution from the energy nutrients that meet blood glucose and other goals of treatment, as well as personal preferences. Eating patterns of pregnant women and pregnant people should be nutritionally adequate and provide at least 175 g of carbohydrate daily as recommended by the Institute of Medicine. It is common for women with gestational diabetes to consume about 45 percent of calories from carbohydrates (around 270 g) daily.[84] Women with gene variants that lead to increased insulin resistance and blood glucose levels when intake of sugars and high-glycemic index sources of carbohydrates such as white rice, potatoes, white bread, and sugar-sweetened beverages are consumed often benefit from reducing intake of these types of foods (Figure 5.2).[84] Table 5.11 provides an example meal plan for a pregnant woman and pregnant person with gestational diabetes that meets nutrient needs and includes low-glycemic-index carbohydrate foods and beverages.

Postpartum Follow-Up About 15 percent of women with gestational diabetes will remain glucose intolerant postpartum, and 10–15 percent will develop type 2 diabetes within 2–5 years. Most women who managed

Table 5.10 Estimating levels of caloric need in women with gestational diabetes[81]

Current Weight Status	BMI, kg/m^2	Calories per kg Body Weight, kcal/kg
Underweight	≤18.5	35–40
Normal weight	18.5–24.9	30–35
Overweight	25–29.9	25–30
Obese	≥30	23–25

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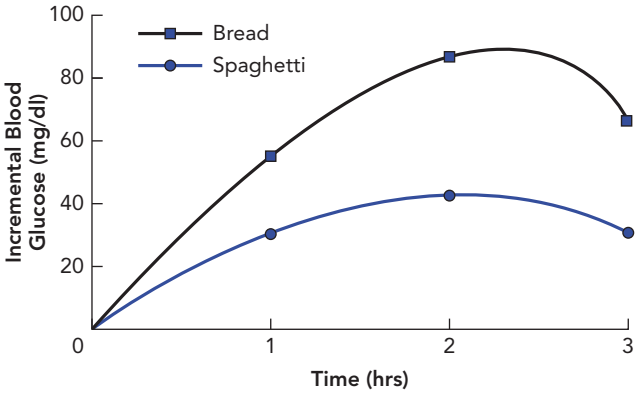


Figure 5.2 Blood glucose levels after a meal containing white bread (GI = 70) or spaghetti (GI = 48) is consumed by individuals with diabetes.

Sources: Graph developed by author from data presented in Riccardi, G., et al. Diabetes: Nutrition in prevention and management. *Nutr Metab Cardiovasc Dis*. 1999; 9:33–36; Wolever, T. M. S., et al. The glycemic index: Similarity of values derived in insulin-dependent and non–insulin-dependent diabetic patients. *J Am Col Nutr*. 1987; 6:295–305; Jenkins, D. J. A., et al. Starchy foods and glycemic index. *Diabetes Care*, 1988; 11:149–159; and Senray, K., & Singhania, P. R. Glycemic Response to common serving size of selected carbohydrate rich foods. *J Res Obes*. 2015. Article ID 614065, doi: 10.5171/2015.614065.

their gestational diabetes with diet and exercise will not require monitoring of blood glucose levels after pregnancy. Women requiring insulin for glucose management should be tested for fasting and 2-hour postprandial blood glucose values before hospital discharge. An oral glucose tolerance test is recommended 6–12 weeks' postpartum in women who were diagnosed with gestational diabetes during pregnancy but tested negative for glucose intolerance postpartum. Negative results should be followed by repeated glucose testing yearly.[59]

Prevention of Gestational Diabetes Reducing overweight and obesity, increasing physical activity, and decreasing insulin resistance prior to pregnancy are important components of reducing the risk of gestational diabetes.[88,89] Risk reduction can also be obtained if a healthy diet and regular exercise are in place before 15 weeks of pregnancy.[59,79] Use of a probiotic supplement such as *Lactobacillus rhamnosus* early in pregnancy appears to reduce insulin resistance and plasma insulin levels in women.[79,80] The risk of type 2 diabetes after pregnancy can be reduced substantially by healthful eating, aerobic and resistance exercise, and maintenance of normal weight.[81,82,90]

Type 2 Diabetes in Pregnancy

More women are entering pregnancy with type 2 diabetes than in the past largely due to increasing rates of obesity.[59] Care for women with type 2 diabetes in pregnancy should be individualized and follow evidence-based protocols. The primary goal of management is maintenance of blood glucose levels within the normal range. This can be challenging because insulin requirements change throughout pregnancy and requires that women be closely monitored and that care providers remain alert and ready to modify care plans. Medical nutrition therapy is a major part of the management of type 2 diabetes during pregnancy, and should be undertaken by an experienced registered dietitian nutritionist in concert with other members of the clinical team and the woman.[59]

Table 5.11 Example of a 1-day meal plan that provides 44 percent of total calories from carbohydrates for a woman with gestational diabetes

2,400-Calorie Meal Plan		
	Carbohydrates, g	**Calories**
Breakfast		
Complete Wheat Bran Flakes, ¾ cup	23	90
2% milk, ½ cup	6	61
Egg, 1	1	74
Black coffee, tea		
Morning Snack		
Peanuts, 2 oz	10	326
Carrot, 1	7	31
Graham crackers, 4 small or 1 sheet	11	59
Lunch		
Beef or chicken burrito, 1 (5 oz)	33	255
Salsa, ½ cup	7	33
Black beans, 1 cup	40	228
Apple, 1	21	81
Black coffee, tea, water, or diet soda		
Midday Snack		
Banana, ½	28	55
2% milk, 1 cup	12	121
Dinner		
Lean pork chop, 4 oz	0	263
Pinto beans, 1 cup	22	116
Corn bread, 1 oz	12	92
Margarine, 1 tsp	1	33
Garden salad, 2 cup	0	10
Feta cheese, 1 oz	1	74
Salad dressing, 2 Tbsp	3	104
Black coffee, tea, water, or diet soda		
Bedtime Snack		
Peanut butter, 2 Tbsp	12	190
Rice cake, 1 (0.5 oz)	8	35
2% milk, 1 cup	12	121
Total:	270 g	2,442

Source: Developed by Judith Brown.

Management of Type 2 Diabetes in Pregnancy

Women with type 2 diabetes are at risk of developing abnormally high and low blood glucose levels. Hypoglycemia

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and hyperglycemia pose threats to maternal and fetal health and should be avoided. Hypoglycemia early in pregnancy is associated with spontaneous abortion and congenital anomalies. It is more likely to occur in the first trimester of pregnancy when insulin requirement may decrease due to nausea and vomiting, weight loss, and other conditions, than later in pregnancy.[57,86] Sustained blood glucose levels over 200 mg/dL (11.1 mmol/L) during pregnancy can result in high blood ketone levels and diabetic acidosis due to the lack of insulin and uptake of glucose by cells. Diabetic acidosis is associated with fetal mortality and decreased intelligence and fine motor skills in offspring.[59]

Table 5.12 summarizes ADA recommendations for the medical and nutritional management of type 2 diabetes during pregnancy.

Women with type 2 diabetes should be followed closely after delivery due to changes in insulin need, and to facilitate weight loss and achievement of normal weight status when needed.[59]

Type 1 Diabetes During Pregnancy

Women with type 1 diabetes have deficient insulin output and must rely on insulin injections or an insulin pump to meet their need for insulin. Type 1 diabetes represents a potentially more hazardous condition to mother and fetus than do most cases of gestational or type 2 diabetes due to the increased risk of kidney disease, hypertension, preeclampsia, and other complications of pregnancy. Newborns of women with this type of diabetes are at increased risk of mortality, of being SGA or LGA, and of experiencing hypoglycemia and other problems within 12 hours after birth. Hypoglycemia occurs in about half of **macrosomic** infants. Coming into pregnancy with this type of diabetes increases the risk of congenital malformations of the pelvis, central nervous system, and heart in offspring (by 2–9 percent). Good control of blood glucose levels before and during pregnancy reduces the risk of malformations and macrosomia substantially.[59]

Blood glucose control from the beginning of pregnancy is also important because the fetal growth trajectory is largely determined in the first half of pregnancy. Exposure to high amounts of glucose and insulin when the fetal growth trajectory is being established may set the "metabolic stage" for fetal accumulation of muscle and fat later in pregnancy. Even relatively low elevations in blood glucose levels can meaningfully increase birthweight.[59,91]

Table 5.12 The ADA recommendations for the management of type 2 diabetes in pregnancy[59]

• Plan pregnancy, achieve good blood glucose control prior to pregnancy
• Replace oral medications for diabetes with insulin before conception
• Self-monitor blood glucose levels
• Achieve blood glucose goals during pregnancy as recommended by guidelines from the American Diabetes Association: – Minimize episodes of hypoglycemia – Time meals and physical activity to correspond with insulin use and blood glucose levels
• Nutritional management – Aim for pregnancy weight gains that correspond to the Institute of Medicine's recommended pregnancy weight gain range by prepregnancy BMI. – Monitor weight gain, adjust energy intake based on rate of gain, physical activity level, and fetal growth pattern. – Develop, implement, monitor, and evaluate a personalized daily food plan based on food preferences, calorie need, and a healthy dietary pattern. – Include around 175 g carbohydrate in the food plan. – Include 28 g of fiber daily from whole grains, vegetables, and good sources of fiber in the food plan. – Monitor dietary intake and adjust dietary pattern, as needed.

Nutritional Management of Type 1 Diabetes in Pregnancy

Primary goals for the nutritional management of type 1 diabetes in pregnancy are continual control of blood glucose level, by way of a healthy dietary pattern and achievement of recommended amounts of weight gain, and a healthy mother and newborn. Careful home monitoring of glucose levels and adjustments in dietary intake, exercise, and insulin dose based on the results are key events that increase the likelihood of reaching these goals. Inclusion of ample amounts of dietary fiber (28–35 g per day) reduces insulin requirements in many women with type 1 diabetes in pregnancy.[92]

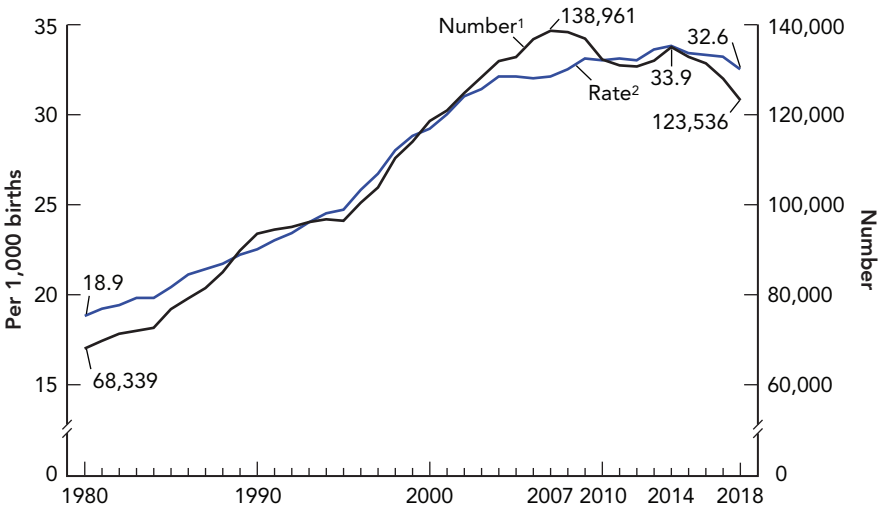
Availability of new types of insulin, the insulin pump for subcutaneous insulin infusion, and self-monitoring technology is revolutionizing the care of type 1 diabetes during pregnancy. An artificial pancreas that utilizes a closed-loop insulin delivery system with continuous glucose monitoring and insulin pump has been developed and may become available for broad use in the future. The device appears to effectively assist in the control of blood glucose levels in individuals with type 1 diabetes.[93]

5.4 Multifetal Pregnancies

Rates of multifetal pregnancy in the United States increased markedly from 1980 to 2009. Rates remained relatively stable from 2009 to 2012 and increased during 2012 and 2014. From 2014 to 2021, rates of multifetal pregnancies

macrosomia A newborn with an excessive birth weight (macro = big, somia = body). Newborn macrosomia has been defined in several different ways, including birth weight of 4,000–4,500 g (8 lb 13 oz to 9 lb 15 oz) or greater than the 90th percentile of weight for gestational age.

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[1]Significant increasing trend for 1980–2007 ($p < 0.05$); significant decreasing trend for 2007–2018 ($p < 0.05$).
[2]Significant increasing trend for 1980–2014 ($p < 0.05$); significant decreasing trend for 2014–2018 ($p < 0.05$).

Figure 5.3 Number and rate of twin births in the United States, 1980–2018.
Sources: www.cdc.gov/nchs/data/databriefs/db80_fig1.png and www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64_01.pdf; and Martin, J. A., & Osterman, M. J. K. Is twin childbearing on the decline? Twin births in the United States, 2014–2018. NCHS Data Brief, no 351. Hyattsville, MD: National Center for Health Statistics. 2019. Available at https://www.cdc.gov/nchs/products/databriefs/db351.htm.

have decreased 8 percent (Figure 5.3).[94,95] Twin births accounted for 1 in 53 births in 1980, and constituted 1 in 31 births in 2021.[95] Rates of triplet and higher-order multiple births (referred to as triplet births) have decreased from the 1998 peak of 1 in 518 to 1 in 1,250 births in 2021 a decrease of 59 percent. Despite an increase of 2 percent in 2021 from 2020 triplet and higher-order multiple births rates of triplet pregnancies are trending downward due to improved **assisted reproductive technologies (ART)** that reduce the number of embryos transferred to, or maintained in, the womb and therefore higher-order multifetal pregnancies.[96]

The progressively older ages at which U.S. women are bearing children also contribute to rising rates of multifetal pregnancies. The chances of a spontaneous multifetal pregnancy increase with age after about 35 years. Rates of spontaneous multifetal pregnancy also increase with increasing weight status. For example, the rate of twin pregnancy is up to two times higher in women with obesity than women who are underweight.[97,98]

Upward trends in low birthweight and preterm delivery in the United States over recent years have been strongly influenced by the upsurge in multiple births. Only 3 percent of newborns are from multifetal pregnancies, yet they account for disproportionally high percentages of all low-birthweight newborns, preterm births, and infant deaths.[96]

assisted reproductive technology (ART)
An umbrella term for fertility treatments such as *in vitro* fertilization (IVF, a technique in which egg cells are fertilized by sperm outside the woman's body), artificial insemination, and hormone treatments.

Background Information about Multiple Fetuses

The most common type of multifetal pregnancies, those with twin fetuses, come in two types and with several levels of risk. Twins are dizygotic (DZ) if two eggs were fertilized, and monozygotic (MZ) if one egg was. Monozygotic twins result when the fertilized and rapidly dividing egg splits in two within days after conception. The term *identical* is often used to describe MZ twins, and *fraternal* denotes DZ twins. These terms are misleading and outdated, and cannot be used to accurately distinguish twin type. The preferred terms are *monozygotic* and *dizygotic*. About 70 percent of twins are DZ, and 30 percent are MZ.[99]

Monozygotic twins are always the same sex, whereas DZ twins are the same sex half the time. Monozygotic twins are genetically identical in almost all ways, but they are seldom absolutely identical. Genetic differences in pairs of MZ twins can result from chromosome abnormalities in one twin, unequal genetic expression of maternally and paternally derived genes, and environmental effects on gene expression. Rates of MZ twins are remarkably stable across population groups and do not appear to be influenced by heredity.[100,101]

Dizygotic twins represent individuals with differing genetic fingerprints. The incidence of DZ twin pregnancies is influenced both by inherited and environmental factors. Rates of DZ twins vary among racial groups and by country. Rates tend to decrease in populations during famine and to increase when food availability and nutritional status improve.[102] Periconceptional vitamin and mineral supplement use has also been related to an increased incidence of DZ twin pregnancy.[101,103]

Twins vary in the number of placentas; some are born having used the same placenta, but more commonly each fetus has its own. Twins may share a common amniotic sac and one of the membranes around the sac (the chorion), or have separate amniotic sacs and membranes (Figure 5.4). Twins at highest risk of death, malformations, growth disparity, short gestation, and other serious problems are those that share the same amniotic sac and chorion, and to a lesser degree, MZ twins in general. Determining twin type is not always an easy task during or after pregnancy. Definitive diagnoses of tough cases can be made through DNA analysis.[96,100,104]

***In Utero* Growth of Twins and Triplets** Fetal growth patterns of twins and triplets are different compared to singleton fetuses (Figure 5.5). Rates of weight gain for each group of fetuses are the same until about 28 weeks

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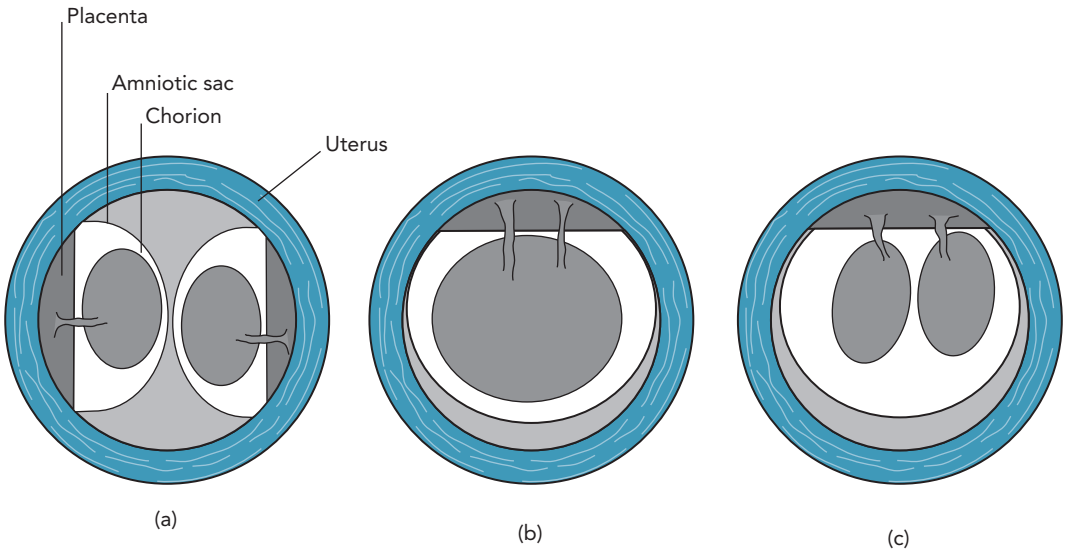


Figure 5.4 Variations in amniotic sacs, chorions, and placentas in twin pregnancy. Drawing (a) shows twins with two amniotic sacs, two chorions, and two placentas. Drawing (b) represents twins sharing one amniotic sac, chorion, and placenta. Drawing (c) shows twins with two amniotic sacs, one chorion, and two placentas that have grown into one.

Sources: Schematic representations drawn by the author with the help of Scott Strachan, 2009; and Types of Twins. Available at https://www/twins.org.au/research/twin-and-data-resource/76-types-of-twins, accessed April 11, 2023, reference #104.

of gestation. Rates of weight gain begin to decline in twin and triplet fetuses after that point, however, and remain lower until delivery. Variations in birthweight of twin and triplet newborns appear to be related to factors that affect fetal growth after 25 weeks of pregnancy.[105]

The Vanishing Twin Phenomenon Fetal loss is difficult and emotional, triggering many feelings. Fetal loss is processed differently by everyone and requires openness and sensitivity when discussing the loss with the pregnant person and their partner. The spontaneous disappearance of embryos within 13 weeks of conception is not unusual. It has been estimated that 6–12 percent of pregnancies begin as twins, but that only about 3 percent result in the birth of twins. Fetal loss in twin pregnancies is estimated to be 15–35 percent.[106] Most fetal losses occur silently by absorption into the uterus within the first 8 weeks after conception. The prognosis for continued viability of a pregnancy associated with a vanishing twin tends to be good.[105] Support groups are available in person and online for those suffering from a fetal loss.

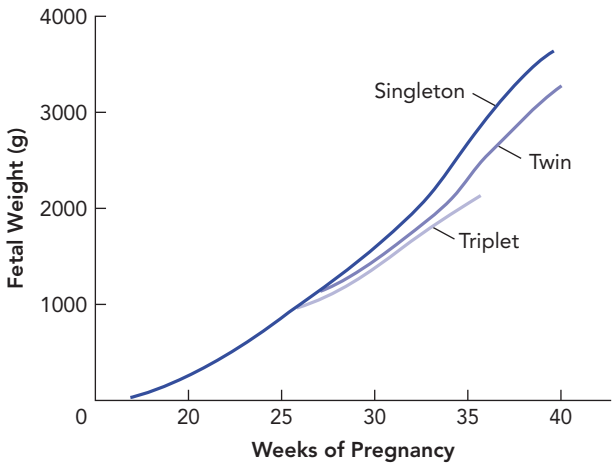


Figure 5.5 Mean fetal weight gain in singleton, twin, and triplet fetuses during pregnancy.

Sources: Graph derived by author from data presented in Kramer, M., et al. A new and improved population-based Canadian reference for birth weight for gestational age. *Pediatrics.* 2001; 108:e35; Kuno, A., et al. Comparison of fetal growth in singleton, twin, and triplet pregnancies. *Hum Reprod. 1999;* 14:1352–1360; and Naeye, R. L., et al. (1966). Intrauterine growth of twins as estimated from liveborn birth-weight data. *Pediatrics.* 1966; 37:409–416.

Risks Associated with a Multifetal Pregnancy

Singleton pregnancy is the biological norm for humans, so it may be expected that multifetal pregnancy would be accompanied by increasing health risks (Table 5.13). Multifetal pregnancies present substantial risks to both mother and fetuses, and the risks increase as the number of fetuses increases (Table 5.14). Newborns from twin pregnancies at lowest risk of death in the perinatal period weigh between 3,000 and 3,500 g (6.7–7.8 lb) at birth and are born at 37–39 weeks' gestation. Triplets tend to do best when they weigh over 2,000 g (4.5 lb) and are born at 34–35 weeks' gestation.[107,108]

Unfortunately, these outcomes do not represent the usual. Median weights of twins born at 37, 38, and 39 weeks' gestation fall below the 3,000- to 3,500-g range (Table 5.15). However, the 3,000- to 3,500-g birthweight range for twins, and the 2,000-gmark for triplet newborns, can serve as goals for the provision of nutrition services.[109,110]

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Table 5.13 Risks to mother and fetuses associated with multifetal pregnancy[96,107]

Pregnant Women
• Preeclampsia
• Iron-deficiency anemia
• Gestational diabetes
• Hyperemesis gravidarum
• Placenta previa
• Kidney disease
• Fetal loss
• Preterm delivery
• Cesarean delivery
Newborns
• Neonatal death
• Congenital abnormalities
• Respiratory distress syndrome
• Intraventricular hemorrhage
• Cerebral palsy
• Low birthweight

Interventions and Services for Risk Reduction

Special multidisciplinary programs that offer women with multifetal pregnancy a consistent, main provider of care; preterm prevention education; increased attention to nutritional needs; and intensive follow-up achieve better pregnancy outcomes than does routine prenatal care.[111] Rates of very low birthweight (1,500 g or 3.3 lb) have been reported to be substantially lower (6 percent versus 26 percent), neonatal intensive care admissions three times lower (13 percent versus 38 percent), and perinatal mortality strikingly lower (1 percent versus 8 percent) among women who receive such services.[112] Interventions offered by the Montreal Diet Dispensary, which focuses on improving the nutritional status and well-being of the pregnant women served, have been shown to substantially reduce poor outcomes compared to those for similar women not receiving the services. Improvements include a 27 percent reduction in the rate of low birthweight, a 47 percent decline in very low birthweight, a 32 percent lower rate of preterm delivery, and a 79 percent drop in mortality during the first 7 days after birth.[113]

Table 5.14 Average birthweight and gestational age at delivery, and low-birthweight rates, of singleton, twin, and triplet newborns[95,108]

	Mean Birthweight	Mean Gestational Age	Low-Birthweight Rate
Singletons	3,440 g (7.7 lb)	39–40 weeks	6%
Twins	2,400 g (5.4 lb)	37 weeks	56%
Triplets	1,800 g (4.0 lb)	33–34 weeks	95%

Table 5.15 Median birthweight for gestational age at delivery of twins

Gestational Age, Weeks	Birthweight
28	995 g (2.2 lb)
29	1,145 g (2.6 lb)
30	1,300 g (2.9 lb)
31	1,445 g (3.2 lb)
32	1,580 g (3.5 lb)
33	1,750 g (3.9 lb)
34	1,905 g (4.3 lb)
35	2,165 g (4.8 lb)
36	2,275 g (5.1 lb)
37	2,430 g (5.4 lb)
38	2,565 g (5.7 lb)
39	2,680 g (6.0 lb)
40	2,810 g (6.3 lb)
41	2,685 g (6.0 lb)

Sources: Data presented in table assembled from Cohen, S. B., et al. (1997). New birthweight nomograms for twin gestation on the basis of accurate gestational age. *Am J Obstet Gynecol.* 1997; 177:1101–1104; and About Twins. Available at twins.com/pregnancy/twin-fetal-weight-chart, accessed April 2023.

Nutrition and the Outcome of a Multifetal Pregnancy

Nutritional factors are suspected of playing a major role in the course and outcome of multifetal pregnancy, but much remains to be learned. Of the nutritional factors that influence multifetal pregnancy, weight gain during twin pregnancy has been studied most.

Weight Gain in a Multifetal Pregnancy

As with a singleton pregnancy, weight gain in multifetal pregnancy is linearly related to birthweight, and weight gains associated with newborn weight vary based on prepregnancy weight status[114,115] (Table 5.16). The Institute of Medicine makes these provisional recommendations for weight gain during a twin pregnancy:[109,110]

- Normal-weight women should gain 37–54 lb (17–25 kg).
- Women who are overweight should gain 31–50 lb (14–23 kg).
- Women with obesity should gain 25–42 lb (11–19 kg).

Table 5.16 Prepregnancy weight status and weight-gain relationships in twin pregnancy[109,110]

Prepregnancy Weight Status	Weight Gain Related to Birthweights of >2,500 g (5.5 lb)
Underweight	44.2 lb (20.1 kg)
Normal weight	40.9 lb (18.6 kg)
Overweight	37.8 lb (17.2 kg)
Obese	37.2 lb (16.9 kg)
Very obese	29.2 lb (13.3 kg)

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These gains are associated with the birth of infants weighing ≥5.5 pounds (≥2.5 kg) on average, at 37–42 weeks' gestation. The report did not identify a recommended range of weight gain for women who are underweight with twins.[116,117] It would be reasonable to conclude that they should gain a somewhat higher range of weight than normal-weight women.

Rate of Weight Gain in a Twin Pregnancy A positive rate of weight gain in the first half of twin pregnancy is strongly associated with increased birthweight.[118,119] On the other hand, weight loss after 28 weeks of pregnancy increases the risk of preterm delivery threefold.[120] Weight gain should be continually positive and add up to about 5–7 lb (2.3–3.2 kg) in the first trimester and then 1–2 lb per week (0.5–0.9 kg) in the second and third trimesters based on prepregnancy weight status.

Weight Gain in a Triplet Pregnancy Several studies have examined the relationship between weight gain and birthweight in women with triplets. The general result is that weight gains of about 50 lb (22.7 kg) correspond to healthy-sized triplets. Rates of gain related to a total weight gain of 50 lb in women who will average 33–34 weeks of gestation are 1.5 lb (0.7 kg) per week or more, starting as early in pregnancy as possible.[118,119]

Dietary Intake in a Twin Pregnancy

Ensuring "adequate nutrition" is widely acknowledged to be a key component of prenatal care for women with multifetal pregnancy. However, it is not clear what constitutes adequate nutrition. Energy and nutrient needs clearly increase during multifetal pregnancy due to increased levels of maternal blood volume; extracellular fluid; and uterine, placental, and fetal growth. The normally high expansion in extracellular volume and its side effect of leg and ankle edema can be seen in the healthy woman with a twin pregnancy (Photo 5.2). Increases in energy and nutrient needs place demands on the mother in terms of the nutritional costs of building and maintaining these tissues. Although their newborns are smaller, women with twins still produce around 11.2 lb (5 kg) of fetal weight, and women with triplets 13.4 lb (5.4 kg) or more.

Evidence of higher caloric need for tissue maintenance and growth in a multifetal than in a singleton pregnancy comes from studies that show increased weight gain and a quicker onset of starvation metabolism in women expecting more than one newborn. Reduced rates of twin deliveries, as well as the higher incidence of twins in women who are overweight or with obesity, imply that energy status is an important factor in multifetal pregnancy.[118,119] Although it is obvious that energy and nutrient needs are higher in a multifetal than a singleton pregnancy, levels of energy balance and nutrient intake associated with optimal outcomes of a multifetal pregnancy have not been quantified.



Elena Yakimova/Shutterstock.com

Photo 5.2 The woman pregnant with twins shown in this photo labeled it, "My poor feet!" The leg and ankle swelling are an expected and normal part of a healthy twin pregnancy.

Results of a large prospective study indicate that women with twins enter pregnancy with higher average caloric intakes (2,030 versus 1,789 calories per day) and consume an average of 265 calories more per day during pregnancy than women with a singleton pregnancy. Nutrient intakes during pregnancy are also higher in women bearing twins than with a singleton pregnancy.[109,110]

Several studies have concluded that the need for specific nutrients is increased during a multifetal pregnancy. The need for essential fatty acids (linoleic and alpha-linolenic acid) appears to be increased in multifetal pregnancy. Requirements for iron and calcium have also been found to be increased based on the magnitude of physiological changes that take place in multifetal pregnancy. Levels of essential fatty acids, iron, or calcium required by women to meet these increased needs are unknown, however.[118,119] Case Study 5.3 addresses a twin pregnancy, and requires use of the American Academy of Nutrition and Dietetics Nutrition Care Process.

Vitamin and Mineral Supplements and a Multifetal Pregnancy Benefits and hazards of multivitamin and mineral supplement use in a multifetal pregnancy have not been reported. Consequently, the extent to which they may be required is unknown. Levels of nutrient intake exceeding the DRI Tolerable Upper Intake Levels should be avoided.

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Case Study 5.3 Twin Pregnancy and the Nutrition Care Process

This case study involves use of the Academy of Nutrition and Dietetics' Nutrition Care Process.

At 37 years of age, Señora Mendez was in her 23rd week of pregnancy and expecting her second child. Or so she thought, until an ultrasound scan detected twins. Her prepregnancy weight was 142 lb (64.5 kg) and her BMI was 23 kg/m^2. Señora Mendez's weight-gain progress has been poor due to nausea and vomiting experienced in the first half of pregnancy. Otherwise, Sra. Mendez was experiencing a normal pregnancy for a woman expecting twins. Concerns about her weight-gain progress and the nutritional needs of women with twin gestation prompted her certified nurse-midwife to prescribe a prenatal vitamin and mineral supplement and to refer her to a registered dietitian/certified diabetes educator.

A nutritional assessment completed during week 25 of pregnancy identified that Sra. Mendez had gained 14 pounds since conception, and that her typical dietary intake excluded fish or other sources of omega-3 fatty acids. Her plasma 25-hydroxyvitamin D level was below 24 nmol/L, indicating low vitamin D status. No other nutrition-related problems were identified.

Questions

1. Assume Sra. Mendez will deliver toward the end of week 37 and is now in the beginning of week 25. How many pounds (or kilograms) should be set as a goal for weekly weight gain if a total pregnancy gain at the midpoint of the provisionally recommended range for weight gain in a twin pregnancy is to be achieved?
2. State three appropriate nutrition diagnoses for this case.
3. Name one potential nutrition intervention that would address each of the nutrition diagnoses stated.
4. Cite a nutrition-related indicator that could be used to monitor and evaluate each of the nutrition interventions stated.



David Buffington/Blend Images/Getty Images

Nutritional Recommendations for Women with a Multifetal Pregnancy

Due to the lack of study results, nutritional recommendations for women with multifetal pregnancy are largely based on logical assumptions and theories (Table 5.17).[118,119,121] It is reasoned, for example, that caloric needs for a twin pregnancy can be extrapolated from weight gain. Theoretically, to achieve a 40-lb (18.2-kg) weight gain, or 10 lb (4.5 kg) more than in a singleton pregnancy, women with twins would need to consume approximately 35,000 calories more during pregnancy than do women with singleton pregnancies. This increase would amount to about 150 calories per day above the level for a singleton pregnancy, or an average of 450 calories more per day than prepregnancy. To achieve higher rates of gain, women who are underweight may need a higher level of intake, and women with obesity or overweight lower levels. Energy needs will also vary by energy expenditure levels. As for a singleton pregnancy, adequacy of calorie intake can often be estimated by weight-gain progress.[114,118]

Food-intake recommendations for women with multifetal pregnancy are primarily estimated based on assumptions related to caloric and nutrient needs. Women with a multifetal pregnancy likely benefit from dietary patterns selected from the MyPlate groups and nutrient intakes that somewhat exceed the RDAs/AIs.

Although twin pregnancies are higher-risk than singleton pregnancies, outcomes of a twin pregnancy can be excellent (Photo 5.3). Their mother remained in good health during pregnancy while consuming the type of diet and supplements and gaining weight as recommended by her health-care providers.

Recommendations from the Popular Press Websites, books, and pamphlets are available that provide ample amounts of scientifically unsupported "guesses" about food and nutrient requirements of women with multifetal pregnancy. Even if presented with steely resolution, any advice that strays from current scientifically based wisdom about nutritional needs of women during pregnancy should be sidestepped.

5.5 Eating Disorders in Pregnancy

For those who have a history of eating disorders, pregnancy can be a trigger to return to previous eating habits or emotions. Eating disorders represent relatively rare conditions in pregnancy because many women with such disorders are subfertile or infertile.[122] Such disorders can have far-reaching effects on both the mother and the fetus, however, when they do occur. The eating disorder most commonly observed among pregnant women in the United States is bulimia nervosa, a condition marked by both

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Table 5.17 Best practice recommendations for nutrition during a multifetal pregnancy[118,119,121]

Weight Gain Twin pregnancy • Overall gain of 35–45 lb (15.9–20.5 kg): Underweight women should gain at the upper end of this range, and overweight and obese women at the lower end. • First trimester: 4–6 lb (1.8–2.7 kg) • Second and third trimesters: 1.5 lb (0.7 kg) per week Triplet pregnancy • Overall gain of approximately 50 lb (22.7 kg) • Gain of 1.5 lb (0.7 kg) per week through pregnancy
Daily Food Intake Twin pregnancy (2,400–2,800 calories a day) • Grains, primarily whole: 8–10 oz • Vegetables: 3–3.5 cups • Fruits: 2–2.5 cups • Fish, poultry, beans: 6.5–7 oz • Milk: 3 cups • Oil: 7–8 tsp • Extra calorie allowance: 362–426 Triplet pregnancy • Food intake from the basic food groups should be consumed at a level that promotes targeted weight gain.
Caloric Intake Twin pregnancy • 450 calories above prepregnancy intake; the amount should be consistent with targeted weight-gain progress. Triplet pregnancy • Caloric intake levels should promote targeted weight-gain progress.
Nutrient Intake Twin and triplet pregnancy • RDA levels or somewhat more than these levels. • Intakes should be lower than ULs.
Vitamin and Mineral Supplements Twin and triplet pregnancy • Use vitamin and mineral supplements as needed.

severe food restriction and bingeing and purging.[123,124] It is estimated that 1–3 percent of adolescents and young women in the United States have this condition. Women with bulimia nervosa exhibit poorly controlled eating patterns marked by recurrent episodes of binge eating. To prevent weight gain, women will induce vomiting, use laxatives, exercise intensely, or fast after binges. Self-worth in women with bulimia nervosa is usually closely tied to their weight and shape. A history of sexual abuse is common among women with this eating disorder, as well as in women with anorexia nervosa.[125]

Women with anorexia nervosa may occasionally ovulate and become pregnant. To women with anorexia nervosa, body weight is of utmost importance, and they are generally



Christophe Ketels/Alamy Stock Photo

Photo 5.3 The outcome of a healthy twin pregnancy: Isa weighed 6 lb, 8 oz (2,912 g) and Manu, 6 lb, 7 oz (2,884 g). The twins were delivered by a scheduled Caesarean section at 38 weeks, 4 days, and were above-average weight for their gestational age.

fully dedicated to achieving and maintaining extreme thinness.[126] Adolescents and women with this condition may refuse to eat, even when ravenously hungry, limit their food choices to low-calorie foods, and exercise excessively.[125]

Eating disorder symptoms often subside during the second and third trimesters of pregnancy, but they rarely vanish altogether. Symptoms tend to return after delivery, sometimes to a more severe extent than was the case prior to pregnancy.[127] Information on eating disorders in nonpregnant individuals is included in Chapter 15.

Consequences of Eating Disorders During Pregnancy

Women with eating disorders during pregnancy are at a higher risk for spontaneous abortion, hypertension, preterm labor, anemia, genitourinary tract infection, and difficult deliveries than are women without an eating disorder. Pregnancy weight gain is variable but often below the recommended amounts, and newborns tend to be smaller and to experience higher rates of neonatal complications.[122,128,129]

Treatment of Women with Eating Disorders During Pregnancy

It is recommended that women and pregnant women with eating disorders be referred to an eating disorders clinic or specialist. Most large communities have special clinics and programs for women with eating disorders, and they commonly use a team approach to problem solving around the eating disorder. Nutritionists or dietitians often participate in these services because they are knowledgeable about the woman's individual nutritional needs and those of pregnancy. Health professionals serving women with eating disorders during pregnancy can facilitate open communication and behavioral change by gently encouraging women to talk about their eating disorder, fears, and concerns.[127,128]

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Nutritional Interventions for Women with Eating Disorders During Pregnancy

Behavioral changes required for improvements in nutritional status and weight gain in women with eating disorders are most likely to work when the changes are considered acceptable to the women with the disorder. Frequently, the health professional presents the types of changes that need to be made and explains why, and then works with the woman to develop specific plans accomplishing these changes.

The term *pregorexia* is emerging in clinical practice as an unofficial term for women with restrictive eating behaviors during pregnancy. The term refers to women with eating disorders who fail to gain weight during pregnancy and are at high risk of intrauterine growth disparity and early delivery. In order to stress the importance of eating right and gaining weight, some dietitians will supply the women with *ketosticks* and ask them to check their urine several times a day. It is explained that when test results are positive for ketones, not enough calories and food are being consumed. It is intended that, faced with positive results about an inadequate food intake, women will eat more.[130]

It can be very difficult to normalize food intake and eating behavior in women with eating disorders or those who have a history of eating disorders. Care should be personalized as some women will gain weight quickly and exceed recommendations while others will struggle to gain any weight at all.[125,126]

5.6 Fetal Alcohol Syndrome

Alcohol consumed by a woman easily crosses the placenta to the fetus. Because the fetus has yet to fully develop enzymes that break it down, alcohol lingers in the fetal circulation. This situation, combined with the fact that the fetus is smaller and has far less blood than the mother does, increases the harmful effects of alcohol on the fetus as compared to the mother.[131]

Fetal exposure to alcohol during pregnancy is a leading, preventable cause of birth defects, intellectual disability, and developmental disorders in children and adults.[106] Knowledge about the potential, adverse effects of alcohol intake very early in and throughout pregnancy is spreading. Consumption of alcohol-containing beverages among women has dropped precipitously among most women while attempting pregnancy or during pregnancy. Although 86 percent of females 18 years of age and older drink, only 8.5 percent drink some amount of alcohol during pregnancy. About 3 percent of women binge drink during pregnancy.[132]

It is estimated that 1 to 5 percent of newborns experience adverse effects related to in utero exposure to alcohol.[133] The risk for development of adverse effects of alcohol exposure increases along with alcohol intake. Infants born to binge drinkers and women who drink consistently throughout pregnancy are at highest risk.[134] Exposure to alcohol during any time period during pregnancy carries with it a risk of long-term, adverse effects on the offspring (Photo 5.4).[135]



Bill Roth/MCT/Newscom

Photo 5.4 A 20-year-old with fetal alcohol syndrome being helped by his adoptive mother. He was born to a woman who drank heavily throughout pregnancy and experiences physical, behavioral, and intellectual problems associated with the severe form of fetal alcohol spectrum disorder.

The term *fetal alcohol syndrome (FAS)* is used to describe the range of affects of fetal alcohol exposure on development and physical growth. The syndrome has two major diagnostic categories:

1. FAS is characterized by the presence of three specific facial features:
   - A smooth ridge between the nose and upper lip
   - Narrow openings between the upper and lower eyelids
   - A thin border on the upper edge of the lip
2. Partial fetal alcohol syndrome (PFAS)
   - Presence of two of the three characteristic facial features

Important effects of fetal alcohol exposure are not visible. They are behavioral and intellectual impairments in offspring including central nervous system abnormalities, poor social and learning skills, and short attention span.[134-136]

It is recommended that women do not drink alcohol-containing beverages during any part of pregnancy, and that attention be paid, and changes instituted as needed, in unhealthy lifestyles and dietary patterns prior to and during pregnancy.[134]

5.7 Nutrition and Adolescent Pregnancy

Teen birthrates have declined by nearly two-thirds in the last 20 years. The 2021 teen birthrates decreased by 7 percent from 2020 which is a new low rate.[95] Declines in adolescent pregnancy in the United States are largely due to increased

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knowledge about effective contraceptive practices, increased availability of contraceptives, use of contraception, and other pregnancy preventive strategies.[137] However, it remains an important issue because of the lifelong consequences of caring for yourself and a child, and its effect on their future prospects of mother and/or father, and the offspring. Teens usually are not financially secure and may not be able to obtain needed health services, or meet their educational expenses, child care support, or assets needed to obtain and prepare nutritious foods.[137,138] Concerns related to adolescent pregnancy are growing in developing nations, where high teen birthrates impact the future health and development of teens and the country.[139] Risks associated with adolescent pregnancy are highest for teens who become pregnant within a few years after the onset of menstruation.[121,140,141]

During these years, teens are gaining weight and height and have relatively high energy and nutrient needs. It is a time when experimentation with drugs and alcohol often occurs, and when dietary quality may take a nose-dive. These conditions, in addition to biological immaturity, contribute to a higher risk of adverse pregnancy outcomes than in older females (Table 5.18).[121,141,142]

Obesity, Excess Weight Gain, and Adolescent Pregnancy

Increasing rates of overweight and obesity among adolescents appear to be placing additional teens at risk of poor pregnancy outcomes. Adolescents entering pregnancy with overweight or obesity are at increased risk for Cesarean delivery, hypertensive disorders of pregnancy, gestational diabetes, and the delivery of excessively large newborns.[143,144] In adolescents who are obese, weight gains during pregnancy that exceed those recommended are related to decreased placental growth and the birth of infants disproportionately small for gestational age.[17] More research is needed to determine why this happens.

Nutritional Recommendations for Pregnant Adolescents

Recommendations for pregnant adolescents are basically the same as for older women and pregnant people, with a few exceptions. Recommendations for weight gain and protein intake are the same, but young adolescents may need more calories to support their own growth as well as that of the fetus. Caloric need should be met by a nutrient-dense diet and lead to rates of weight gain that follow those recommended. Pregnant adolescents have a higher requirement for calcium. The RDA for pregnant teens for calcium is 1,300 mg per day, or 300 mg higher than for pregnant adults. This increased need can be met by the consumption of four daily servings of milk and milk products, combined with a varied, basic diet. Since calcium and vitamin D are both needed in adequate amounts for the teen's and the fetus' bone formation, sufficient intake of both nutrients is seen as particularly important during teen pregnancy.[145]

The importance of lifestyle and other environmental factors to pregnancy outcome in teens emphasizes the need for special, comprehensive teen pregnancy health-care programs. Nutrition counseling is an important component of the multidisciplinary services that should be offered to pregnant adolescents. Nutrition services that include individualized nutrition assessment, intervention, education, guidance on weight gain, and follow-up enhance birthweight outcomes. Additional specialized services that focus on the psychosocial needs of pregnant adolescents, support/discussion groups, and home visits also contribute to improved maternal and infant outcomes for adolescents.[146] Because most pregnant adolescents have little to no income, referrals to appropriate food and nutrition programs and other assistance related to health care, housing, and education should be core components of services.

Table 5.18 Risks associated with adolescent pregnancy[137-140]

• Low birthweight
• Perinatal death
• Caesarean delivery
• **Cephalopelvic disproportion** (head too large for birth canal)
• Preeclampsia
• Iron-deficiency anemia
• Delayed, reduced educational achievement
• Poverty
• Poor diet quality

SARS-CoV-2 (COVID-19)

COVID-19 infection during pregnancy is related to a number of adverse outcomes, including an increase in preterm delivery, preeclampsia, blood clot formation, and newborn deaths.[147] The infection has its greatest impact on pregnant people who are Black or Hispanic.[148] This increased risk level appears to be due to food cost and availability, and crowded living conditions.

The COVID-19 vaccination effectively lowers the risk of adverse outcomes and is recommended for women who are or may become pregnant, along with wearing a mask around other people.[149]

Evidence-Based Practice

The clinical nutritional management of the conditions covered in this chapter, as well as other complications during

cephalopelvic disproportion A mismatch between the size of the fetal head and size of the maternal pelvis, resulting in "failure to progress" in labor for mechanical reasons.

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pregnancy, are not always evidence based due to the lack of knowledge or availability of qualified nutrition professionals. Such practices are a problem when they burden women and families with costs, call for dietary changes not known to work, or potentially cause harm. Practices not based on evidence that likely pose little risk or burden and may potentially be of help should nonetheless be carefully evaluated. Outdated practices often linger far too long, at the expense of missed opportunities for real improvements.

Use of practices not supported by scientific evidence should always be questioned and confirmed to represent "best practices" insofar as that can be determined. To know what a best practice is requires vigilant attention to scientific developments related to the nutritional management of clinical conditions during pregnancy.

Key Points

1. Maternal eating patterns, weight status, and physical activity levels influence the development of healthy pregnancy outcomes and a number of conditions that adversely affect the course and outcome of pregnancy.
2. Nutritional interventions for a number of pregnancy complications can benefit maternal and infant health outcomes.
3. Oxidative stress and endothelial dysfunction appear to be related to the development and progression of hypertensive disorders of pregnancy.
4. High BMI/body fat, low levels of physical activity, lack of antioxidants, and elevated blood glucose increase oxidative stress. This is lowered by weight loss in individuals that are overweight, increased levels of exercise, normal blood glucose levels, and sufficient intake of antioxidants from components of a healthy dietary pattern.
5. Nutritional management of gestational diabetes focuses on individually based dietary and exercise plans that help maintain blood glucose levels within the normal range and that foster maternal health and appropriate weight gain.
6. There is no set range of percent of calories from the macronutrients that works best for all women with diabetes during pregnancy.
7. Multifetal pregnancies are classified as "high risk" because of above-average rates of complications and less-than-optimal pregnancy outcomes. Energy, nutrient, and weight-gain needs are somewhat higher in a multifetal than a singleton pregnancy.
8. The dietary pattern recommended for women with gestational diabetes focuses on replacing high-sugar beverages and foods, and refined carbohydrates with whole grain products, vegetables, nuts, and other nutrient-dense, minimally processed foods.
9. Most women diagnosed with gestational diabetes can manage blood glucose levels throughout pregnancy by lifestyles that include consumption of a healthy dietary pattern, regular physical activity, and gaining weight appropriately.
10. It is estimated that 1–5 percent of newborns experience adverse effects related to *in utero* exposure to alcohol. Important effects of fetal alcohol exposure are not visible. They are behavioral and intellectual impairments including central nervous system impairments, poor learning and social skills, and short attention span.
11. Women with eating disorders should be closely monitored during pregnancy by an interdisciplinary, experienced clinical team to facilitate appropriate dietary intake, weight gain, and long-term eating habits and weight status.
12. Growing adolescents are at risk of poor pregnancy outcomes. Pregnancy outcomes of adolescents who are not growing primarily depend on the health status of the teen. Dietary quality and weight status are important components of the health status of adolescents and influence the course and outcome of their pregnancies.
13. Nutritional interventions during pregnancy should be based on scientific evidence that supports their safety, effectiveness, and affordability.

Review Questions

1. Obesity prior to pregnancy is associated with metabolic disorders that promote the development of hypertensive disorders of pregnancy and gestational diabetes.

   _____ True _____ False

2. Bariatric surgery prior to pregnancy decreases the risk of gestational diabetes and preeclampsia during pregnancy.

   _____ True _____ False

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3. Chronic inflammation and oxidative stress occur in preeclampsia but not in other hypertensive disorders of pregnancy.

   _____ True _____ False

4. Supplementation with vitamins C and E before and early in pregnancy is associated with a decreased risk of preeclampsia during pregnancy.

   _____ True _____ False

5. Salt restriction during pregnancy decreases the incidence of all forms of hypertension during pregnancy and is recommended for all pregnant women.

   _____ True _____ False

6. Gestational diabetes is associated with high blood triglyceride levels.

   _____ True _____ False

7. It is recommended that women with diabetes gain 5 lb (2.3 kg) less during pregnancy than the IOM-recommended, lower limit of their weight-gain range based on prepregnancy BMI.

   _____ True _____ False

8. _____ Assume Minh, who weighed 123 lb and was 5'4" tall prior to pregnancy, is diagnosed with gestational diabetes at 25 weeks of gestation. She is referred to a registered dietitian for medical nutrition therapy. Which of the following statements of advice would be appropriate for the dietitian state related to Minh's dietary intake?

   a. Eat only carbohydrates that are not white.
   b. Reduce salt intake to a minimum.
   c. Reduce calorie intake to less than 1,900 calories per day.
   d. Distribute carbohydrate intake across meals and snacks.

9. Women with type 1 diabetes during pregnancy benefit from a sufficient intake of dietary fiber (25–35 g per day).

   _____ True _____ False

10. The American Diabetes Association recommends that women with diabetes during pregnancy monitor urine glucose and ketone levels daily.

    _____ True _____ False

11. It is estimated that women with a twin pregnancy need 150 calories more each day than do women with a singleton pregnancy.

    _____ True _____ False

12. Physical activity is not recommended during multifetal pregnancy.

    _____ True _____ False

13. Adequate intake of fiber, especially soluble fiber from dried beans, fruits, and vegetables, is particularly encouraged due to beneficial effects on gut microbiota, inflammation, glucose levels, and insulin resistance.

    _____ True _____ False

14. Women with anorexia nervosa cannot conceive because they do not ovulate.

    _____ True _____ False

15. Risks associated with adolescent pregnancy are highest for teens who become pregnant within a few years after the onset of menstruation.

    _____ True _____ False

16. Time-tested clinical assumptions about appropriate dietary therapies during pregnancy tend to work as well in practice as do evidence-based therapies.

    _____ True _____ False

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6

Nutrition During Lactation

Prepared by Ellen Lechtenberg and Maureen Murtaugh

Learning Objectives

After studying the materials in this chapter, you should be able to:

6.1 Describe the development, the structure, and the functional components of the mammary gland. Describe the key hormonal influences on development and function.

6.2 Identify similarities and differences in nutrient levels between colostrum and mature human milk, and between mature human milk, whole cow's milk, and human milk substitutes (infant formula).

6.3 Summarize the benefits of breastfeeding/chestfeeding for mothers and their babies in a manner that could be included in breastfeeding education for pregnant mothers, their partners, and family members.

6.4 Generate an education plan for new mothers that includes the answers to common questions about milk supply, including what is typical milk production; what is the relationship between infant demand and maternal supply; and the influence of the size of the breast, feeding frequency, pumping, and breast surgeries on milk production.

6.5 Describe maternal steps to prepare the breast, and the basic position of the infant at the breast.

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6.6 Describe infant behaviors that indicate readiness to feed, and vitamin supplement recommendations for breastfeeding/chestfeeding infants.

6.7 First, identify the professional and government sources of nutrient recommendations for healthy women for diet and supplements. Second, list common nutrition diagnoses for breastfeeding women, coupled with nutrition intervention and appropriate parameters for monitoring.

6.8 Identify at least two breastfeeding promotion programs that have demonstrated effectiveness at increasing breastfeeding initiation and duration.

6.9 Summarize factors known to be associated with higher and lower rates of breastfeeding, and the gap between current rates and the Breastfeeding Goals for the United States.

Introduction

The health-care system, the workplace, and the community can either hinder or facilitate the initiation and continuation of breastfeeding/chestfeeding. Health programs can play a significant role in increasing and supporting sustained breastfeeding rates to optimize maternal and infant nutrition. Health-care professionals who wish to manage and promote breastfeeding should understand the physiology of lactation, the composition of human milk, and the benefits to mothers and infants. Helping women and all individuals who provide human milk feedings to achieve or maintain appropriate nutritional status to optimize breastfeeding requires consideration of energy and nutrient needs, weight goals, effects of exercise during breastfeeding, and vitamin and mineral supplement needs. The Academy of Breastfeeding Medicine Position Statement and Guideline on Infant Feeding and Lactation-Related Language and Gender stresses the importance of acceptance, and use of gender inclusive language when discussing and providing education on infant feeding. Breastfeeding, chestfeeding, and human milk feeding individuals all lactate. Not all people who lactate have given birth, nor do they all identify as female. This is true for people who have given birth. Not all persons who have given birth identify as female or as mothers. It is important working with women and lactating persons to establish the pronouns they identify with and to use those pronouns consistently during interactions with the family to be inclusive and nondiscriminatory. The majority of research studies on breastfeeding benefits for infants and women have been conducted with persons who have been assigned female at birth. Changing the language in studies to lactating persons or parental to be more inclusive is misleading and inaccurate as the study methods have not included males assigned at birth who identify as females.[1] Much research is needed in transgender populations and all people who which to breastfeed, chestfeed, and provide human milk.[1] The terms breastfeeding and mothers are used in this chapter. Use of terms identified by the individual or family members including chestfeeding, lactating persons, birthing parent/person, and lactating person or individual who provides human milk should be used.

The benefits of breastfeeding to mothers and infants are well established. Federal breastfeeding promotion efforts and greater understanding of the advantages of breastfeeding have contributed to the resurgence of breastfeeding in the United States since the 1970s. Nevertheless, racial and ethnic disparities in breastfeeding initiation rates remain. According to the Centers for Disease Control and Prevention (CDC), Asian infants, non-Hispanic White infants and Hispanic Infants were more likely than non-Hispanic Black infants to be ever breastfed.[2] In the last decade, gains were realized in both initiation and duration of breastfeeding, but there is still a long way to go to reach exclusive breastfeeding for 4–6 months and continued breastfeeding for at least a year to optimize health for women and children.

Multilevel (health-care system, community, workplace, and family) support is critical for women who experience common breastfeeding challenges and medical conditions and their infants. Human milk is the preferred food for healthy and premature and sick newborns. It is rarely necessary to discontinue breastfeeding to manage medical problems or medication use. However, adequately experienced and informed health-care professionals such as International Board Certified Lactation Consultants (IBCLC) and Certified Lactation Educators (CLE) are needed to provide support for successful breastfeeding. Common breastfeeding conditions and interventions are discussed in Chapter 7.

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6.1 Lactation Physiology

Functional Units of the Mammary Gland

The functional units of the **mammary gland** are the **alveoli** (Figure 6.1). Each alveolus is composed of a cluster of cells (**secretory cells**) with a duct in the center, whose job it is to secrete milk. The ducts are arranged like branches of a tree, each smaller duct leading to 6–10 larger collecting ducts. These branchlike collecting ducts lead to the nipple. **Myoepithelial cells** surround the secretory cells. Myoepithelial cells can contract under the influence of **oxytocin** and cause milk to be ejected into the ducts.

Mammary Gland Development

During puberty, the ovaries mature and the release of estrogen and progesterone increases (Table 6.1). The cyclic release of these two hormones governs pubertal breast development (Figure 6.2). The mammary gland develops its lobular structure (**lobes**) under the cyclic production of progesterone and is usually complete within 12–18 months after menarche. As the ductal system matures, cells that can secrete milk develop, the nipple grows, and its pigmentation changes. Fibrous and fatty tissues increase around the ducts.

In pregnancy, the luteal and placental hormones (placental lactogen and chorionic gonadotropin) allow further preparation for breastfeeding (Figure 6.2). Estrogen stimulates development of the glands that will make milk. Progesterone allows the tubules to elongate and the cells that line the tubules (epithelial cells) to duplicate.[2] Prolactin is needed for lobular-aveolar development of the gland to be completed.[3]

Lactogenesis

The mammary gland transitional changes from pregnancy to lactation are known as **lactogenesis**. Mammary gland development and hormonal control involved in lactation occur in five stages. These five stages are **mammogenesis**, lactogenesis stage I, lactogenesis stage II, full lactation or **galactopoiesis** also known as stage III lactogenesis, and involution following the last breastfeeding by approximately 40 days. Lactogenesis is classically described as occurring in three stages.[3,4]

The first stage, or lactogenesis I, begins during the last trimester of pregnancy at approximately 12 weeks before delivery; the second and third stages (lactogenesis II and III)

mammary gland The source of milk for offspring, also commonly called the breast. The presence of mammary glands is a characteristic of mammals.

alveoli A rounded or oblong-shaped cavity present in the breast.

secretory cells Cells in the acinus (milk gland) that are responsible for secreting milk components into the ducts.

myoepithelial cells Specialized cells that line the alveoli and that can contract to cause milk to be secreted into the duct.

oxytocin A hormone produced during letdown (natural reflex) that causes milk to be ejected into the ducts.

lobes Rounded structures of the mammary gland.

lactogenesis Another term for human milk production.

mammogenesis Another term for mammary growth

galacopoiesis Another term for maintenance of lactation following the establishment of lactation

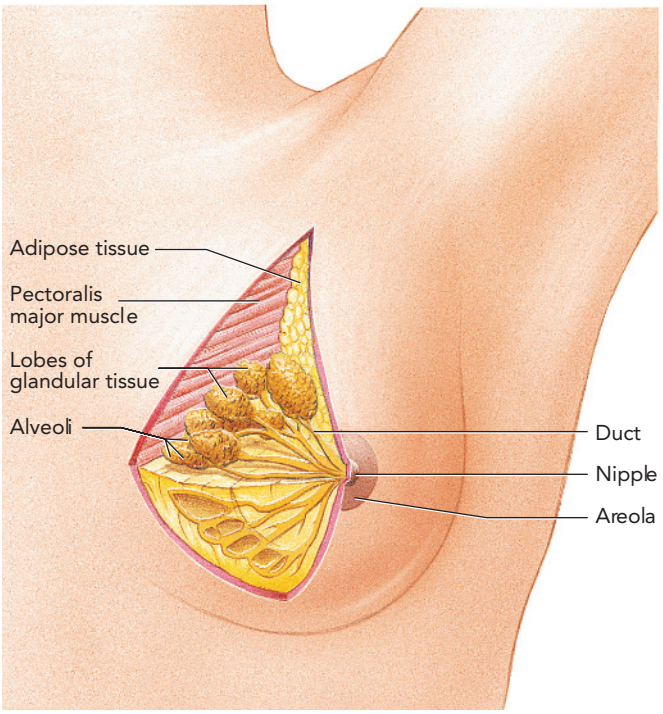


Figure 6.1 Breast of a lactating female.
This cutaway view shows the mammary glands and ducts.

Table 6.1 Hormones contributing to breast development and lactation

Hormone	Role in Lactation	Stage of Lactation
Estrogen	Ductal growth	Mammary gland differentiation with menstruation
Progesterone	Alveolar development	After onset of menses and during pregnancy
Human growth hormone	Development of terminal end buds	Mammary gland development
Human placental lactogen	Alveolar development	Pregnancy
Prolactin	Alveolar development and milk secretion	Pregnancy and breastfeeding (from the third trimester of pregnancy to weaning)
Oxytocin	Letdown: ejection of milk from myoepithelial cells	From the onset of milk secretion to weaning

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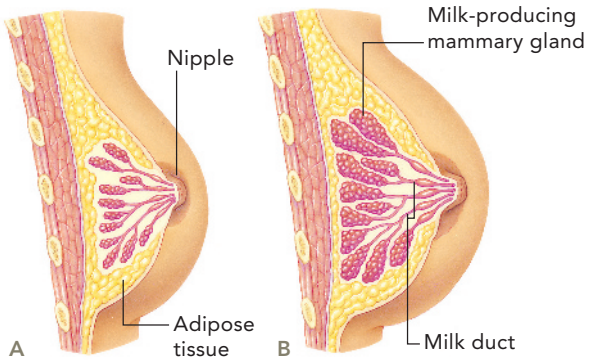


Figure 6.2 Breast of a mature woman, before pregnancy and during lactation.

occur after birth. Lactogenesis may be impacted by premature delivery, method of delivery, maternal high BMI greater than 30, diabetes, and other factors. These may explain why mothers who deliver prematurely are often unable to develop a full milk supply (25–35 oz per day).

- **Lactogenesis I.** During the first stage of milk production, milk begins to form, and the lactose and protein content of milk increase. This stage begins during pregnancy at approximately 16 weeks and extends through the first few days postpartum. During this stage, there are large gaps between the aveolar cells.
- **Lactogenesis II.** This stage begins 2–3 to 8 days postpartum and is marked by increased blood flow to the mammary gland and a decrease in maternal progesterone levels. The tight junction complexes between aveolar cells close in the first 3 to 4 days because of changes in cellular metabolism preventing the passage of substances between aveolar cells.[3] Clinically, it is considered the onset of copious milk secretion, or when milk "comes in." Significant changes in both the milk composition and the quantity of milk that can be produced occur over the first 10 days of the baby's life. Delayed lactogenesis II is associated with failure to sustain breastfeeding.[5-8]
- **Lactogenesis III.** This stage of breast milk production begins about 9 days after birth and is the stage in which milk supply is maintained and the milk composition becomes stable.[5]

Hormonal Control of Lactation

Prolactin and oxytocin are necessary for establishing and maintaining a milk supply (Table 6.1). **Prolactin** is a hormone that stimulates milk production. Suckling is a major stimulator of prolactin secretion: prolactin levels double with suckling.[4,7] Stress, sleep, and sexual intercourse also stimulate prolactin levels. Prolactin activity is suppressed by a prolactin-inhibiting factor that is released by the hypothalamus to allow the mother's body to prepare for milk production during the last 3 months of pregnancy without making milk. Prolactin plasma levels peak during lactogenesis III and are related to the amount of nipple stimulation after the first 4 days during lactogenesis II.[3] Night breastfeeding or pumping is crucial to build a full supply due to increases in prolactin secretion at night.[7] The actual level of prolactin in the blood is not related to the amount of milk made, but prolactin is necessary for milk synthesis to occur.[9]

Oxytocin release is also stimulated by suckling or nipple stimulation and some sensory pathways. Its main role is in letdown or the natural ejection of milk from the milk gland (**acinus**) into the milk ducts. Women may experience tingling or sometimes sharp shooting pain that lasts about a minute and corresponds with contractions in the milk ducts. Oxytocin also acts on the uterus during and after delivery, causing it to contract, seal blood vessels, and shrink its size.

Secretion of Milk

The process of milk production is complex. Understanding the basic mechanisms of milk secretion helps understand how factors such as nutritional status, supplementation, medications, and disease may affect breastfeeding or milk composition. Lactose, for example, is made in the secretory cells and secreted into ducts by the process of **exocytosis**. Milk fat comes from triglycerides from the mother's blood and from new fatty acids produced in the breast becoming fat droplets. These droplets become surrounded by a portion of the cell membrane as they are secreted into the milk duct. Ions including sodium and potassium, and water are **actively transported** from the cell into milk. Proteins including immunoglobulins, hormones, and albumin, and other plasma proteins are also captured from the mother's blood (**transcytosis**) and taken into the alveolar cells[10] before being secreted into the milk ducts. This process occurs following the closure of the tight junctions between the aveoli cells. Leukocytes and other components from the mother's plasma pass directly between cells (paracellular pathway).

prolactin A hormone necessary for milk production.

acinus Small sacs lined by cells that produce milk.

exocytosis The process by which the contents of vacuoles in the cell are carried to the exterior of the cell by fusing the membranes of the vacuole and the cell.

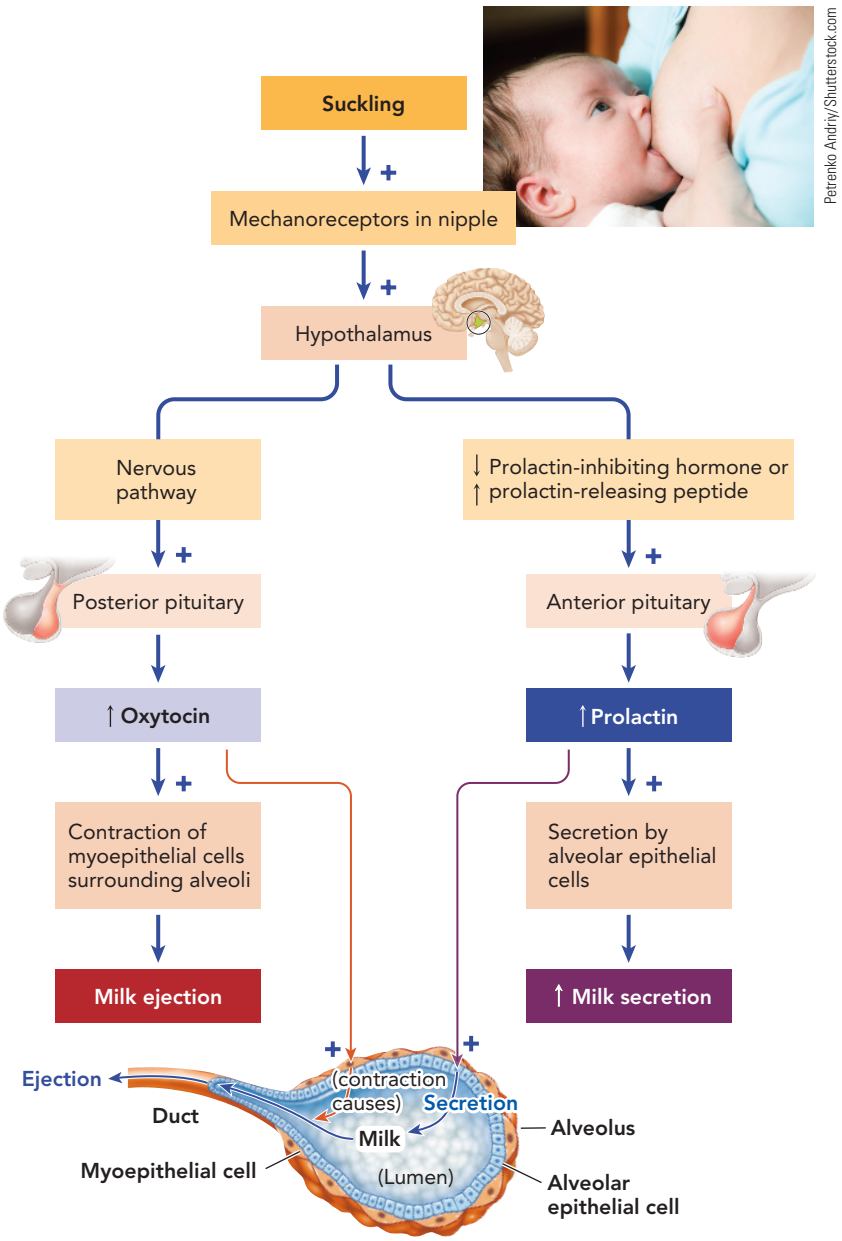
active transport The flow of atoms, ions, or water from lower concentration to higher concentration. This process requires energy and is assisted by enzymes.

transcytosis Transport of macromolecules across the interior of a cell. Macromolecules are captured in a sac from mother's serum drawn across the cell, and released into the milk ducts.

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The Letdown Reflex

The letdown reflex stimulates milk release from the breast. The stimuli from the infant suckling are passed through nerves to the hypothalamus, which responds by promoting oxytocin release from the posterior pituitary gland (Figure 6.3). The oxytocin causes contraction of the myoepithelial cells surrounding the secretory cells. As a result, milk is released through the ducts, making it available to the infant. Other stimuli, such as hearing a baby cry, sexual arousal, and thinking about nursing, can also cause letdown, and milk will leak from the breasts.



Petrenko Andriy/Shutterstock.com

Figure 6.3 The letdown reflex.
An infant suckling at the breast stimulates the pituitary to release the hormones prolactin and oxytocin.

6.2 Human Milk Composition

"The nutritional value of breast milk has been widely recognized. Its composition in terms of macro and micronutrients has been widely investigated, highlighting how these components change dynamically according to factors including lactation stages, time of the day, maternal and infants' characteristics."

—Vizzari et al. (2021)[11]

Human milk is an elegantly designed natural resource. It is the only food needed by the majority of healthy infants for approximately the first 6 months containing all the nutrients for optimal growth and development. The composition of milk is designed not only to nurture, but also to protect infants from infectious and chronic diseases such as celiac disease, inflammatory bowel disease, diabetes, and leukemia.[4,11] Human milk composition is changeable over a single feeding, over a day, according to the age of the infant, or gestation at delivery, with the presence of infection in the breast, with menses, with maternal nutritional status, and by geographical location. These changes in human milk composition appear to change to meet the changing requirements of the infant.[12]

Human milk is species specific to meet the needs of human infants. Just as the different components change in human milk to provide nutritive and bioactive properties, other mammal species milk varies to meet each species nutritional needs, environmental conditions, and genetics. Nutrient dense mammal milk with high fat content correlates with rapid growth patterns and days required to double birthweight. Research on different constituents in mammal species milk is ongoing. Table 6.2 lists several nutritional components in four species of mammal milk compared with human milk.

As our ability to measure and identify novel components increases, we recognize that the composition of human milk is complex. Hundreds of components of human milk have been identified, and their nutritive and nonnutritive roles are under investigation.[12,13] The basic nutrient composition of colostrum and mature milk is provided in Table 6.3.[14] Composition of mature milk with human milk substitutes is provided in Table 6.4. International standards for human

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Table 6.2 Nutritional components of mammal milk

Mammal	Fat %	Cholesterol mg/dL	Lactose %	Protein %	Iron mg/dL	Sodium mg/dL	Potassium mg/dL	Calcium mg/dL	Magnesium mg/dL	Zinc mg/dL
Human	3.53 ± 1.02	9.9 ± 6.51	7.0	0.9	0.20 ± 0.10	15.9 ± 1.5	71.3 ± 9.0	27.6 ± 2.9	3.8 ± 1.4	0.46 ± 0.2
Cow	2.90 ± 0.19	20.58 ± 4.21	4.8	3.4	0.08 ± 0.02	49.3 ± 5.3	147.9 ± 19.7	119.8 ± 12.5	12.6 ± 1.9	0.62 ± 0.18
Mare	1.21 ± 0.85	6.30 ± 1.08	6.2	2.5	0.21 ± 0.11	17.4 ± 3.2	87.1 ± 18.3	92.9 ± 5.8	8.1 ± 3.2	0.21 ± 0.11
Sheep	7.10 ± 3.21	17.07 ± 1.18	4.8	4.8	0.08 ± 0.02	52.1 ± 3.2	178.8 ± 84	12.5 ± 3.1	12.5 ± 3.1	0.58 ± 0.21
Goat	4.14 ± 1.29	11.64 ± 1.09	4.1	4.1	0.07 ± 0.02	35.9 ± 2.4	183.6 ± 17.2	17.3 ± 2.7	17.3 ± 2.7	0.69 ± 0.17

Sources: Adapted from Lawrence, *Breastfeeding: A Guide for the Medical Professional* (2021)[3] and Kim (2020).[7]

Table 6.3 Compositions of 100 mL colostrum (days 1–5 postpartum) and mature milk (day 15 postpartum)

Contents	Colostrum	Mature Milk
Calories (kcal)	60	65–75
Fat (g)	2.6	3.5
Lactose (g)	5.3	7.0
Total protein (g)	2.0	1.1
Secretory IgA	0.5[a]	0.1
Lactoferrin	0.5	0.2
Casein	0.5	0.3
Calcium (mg)	26	28
Phosphorus (mg)	11	14
Sodium (mg)	48	15
Vitamin A (µg retinol equivalents)	151	75
Vitamin B_1 (µg)	2	14
Vitamin B_2 (µg)	30	40
Vitamin C (µg)	6	5

[a]Concentration is considerably higher at 1–3 days postpartum than at days 4 and 5.

Sources: Adapted from Prentice A. Constituents of human milk. *Food and Nutrition Bulletin*, 1996; *17*(4), The United Nations University Press;[14] and Gidrewicz, D. A. A systematic review and meta-analysis of the content of preterm and term breastmilk. *BMC Pediatr.* 2014.[15]

milk substitutes are set by the Codex Alimentarius Commission of the Food and Agriculture Organization (FAO) of the United Nations and the World Health Organization (WHO).[16] The composition of specific products vary across brand and with time. Their composition can be found on websites maintained by the producers of these products.

Colostrum

The first milk, **colostrum**, is a thick, often yellow fluid produced during lactogenesis II (days 1–3 after infant birth). Infants may drink only 2–20 mL (0.5 to 0.5–4 tsp) of colostrum per feeding in the first 2–3 days.[3,4] Colostrum provides about 580–700 kcal/L with an average energy value of 670 kcal/L and is higher in protein and minerals and lower in carbohydrate, fat, and vitamins than mature milk (produced 2–3 weeks after infant birth).[16] Secretory immunoglobulin A and lactoferrin are the primary proteins present in colostrum, while other proteins present in mature milk are not present. The concentration of mononuclear cells (a specific type of white blood cell from the mother that provides immune protection) is highest in colostrum. Colostrum has higher concentrations of nutrients, including sodium, potassium, vitamin E,[3,17] carotenoids, and chloride than more mature milk.

Water

Breast milk is **isotonic** with plasma. This biological design of milk means that babies do not need water or other fluids to maintain hydration, even in hot and dry weather.[18] As a major component of human milk, water allows suspension of the milk sugars, proteins, immunoglobulin A, sodium, potassium, citrate, magnesium, calcium, chloride, and water-soluble vitamins.

Energy

Human milk provides approximately 0.65–0.75 kcal/mL with the energy content widely varying between lactating mothers with its fat (and, to a lesser degree, protein and carbohydrate) composition. Breastfed infants consume fewer calories than infants fed human milk substitute (HMS).[3,19,20] It is not known whether this difference in energy intake of breastfed infants has to do with the composition of human milk versus human milk substitutes, the inability to see the volume of feedings when providing human milk, the differences in the suckling at the breast compared to an artificial nipple, or other factors. Enhanced growth during the first 3-4 months of life is seen in infants with prolonged and exclusive breastfeeding.[4] At 8–11 months, infants who are breastfed are thinner for their weight than bottle fed infants, or infants fed HMS, but these differences disappear by 12–23 months of age and few differences are notable by 5 years of age.[21]

colostrum The milk produced in the first 2–3 days after the baby is born. Colostrum is higher in protein and lower in lactose than milk produced after a milk supply is established.

isotonic Similar salt concentration as the blood.

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Table 6.4 Human and cow's milk and human milk substitute (HMS, or infant formula) composition

Nutrient	Units	Human Milk (1 fl oz)	Whole Cow's Milk (1 fl oz)	Nestle Good Start (1 fl oz)
Water	g	26.95	26.94	26.69
Energy	kcal	22	19	20
Energy	kJ	90	78	84
Protein	g	0.32	0.96	0.44
Total lipids (fat)	g	1.35	0.99	1.03
Carbohydrate	g	2.12	1.46	2.25
Fiber, total dietary	g	0	0	0
Sugars, total	g	2.12	1.6	1.52
Minerals				
Calcium, Ca	mg	10	34	13
Iron, Fe	mg	0.01	0.01	0.3
Magnesium, Mg	mg	1	3	2
Phosphorus, P	mg	4	26	7
Potassium, K	mg	16	40	22
Sodium, Na	mg	5	13	5
Zinc, Zn	mg	0.05	0.11	0.16
Copper, Cu	mg	0.016	0.008	0.016
Manganese, Mn	mg	0.008	0.001	0.003
Selenium, Se	mcg	0.6	1.1	0.4
Vitamins				
Vitamin C, total ascorbic acid	mg	1.5	0	1.8
Thiamin	mg	0.004	0.014	0.02
Riboflavin	mg	0.011	0.052	0.028
Niacin	mg	0.055	0.027	0.211
Pantothenic acid	mg	0.069	0.114	0.015
Vitamin B_6	mg	0.003	0.011	5
Folate, DFE	mcg_DFE	2	2	0.07
Vitamin B_{12}	mcg	0.02	0.14	18
Vitamin A, RAE	mcg_RAE	19	14	0.3
Vitamin E (alpha tocopherol)	mg	0.02	0.02	13
Vitamin D	IU	1	16	1.6
Vitamin K (phylloquinone)	mcg	0.1	0.1	
Lipids	g	0.619	0.569	0.448
Saturated fatty acids, total	g	0	0.023	0
4:00	g	0	0.023	0
6:00	g	0	0.023	0
8:00	g	0	0.023	0.015
10:00	g	0.019	0.023	0.012
12:00	g	0.079	0.023	0.104
14:00	g	0.099	0.091	0.043
16:00	g	0.283	0	0.238
18:00	g	0.09	0.253	0.037
Monounsaturated fatty acids, total	g	0.511	0	0.329
Polyunsaturated fatty acids, total	g	0.153	0	0.226
Cholesterol	mg	4	0	1

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Table 6.4 Human and cow's milk and human milk substitute (HMS, or infant formula) composition (continued)

Nutrient	Units	Human Milk (1 fl oz)	Whole Cow's Milk (1 fl oz)	Nestle Good Start (1 fl oz)
Amino acids				
Tryptophan	g	0.005	0.022	
Threonine	g	0.014	0.043	
Isoleucine	g	0.017	0.049	
Leucine	g	0.029	0.079	
Lysine	g	0.021	0.042	
Methionine	g	0.006	0.022	
Cystine	g	0.006	0.005	
Phenylalanine	g	0.014	0.044	
Tyrosine	g	0.016	0.045	
Valine	g	0.019	0.057	
Arginine	g	0.013	0.022	
Histidine	g	0.007	0.022	
Alanine	g	0.011	0.031	
Aspartic acid	g	0.025	0.071	
Glutamic acid	g	0.052	0.193	
Glycine	g	0.008	0.022	
Proline	g	0.025	0.102	
Serine	g	0.013	0.032	

Source: U.S. Department of Agriculture, Agricultural Research Service. 2019. USDA National Nutrient Database for Standard Reference, Release. Nutrient Data Laboratory Home Page, www.ars.usda.gov/nutrientdata.

Lipids

Lipids are the second-largest component of breast milk by concentration (3–5 percent in mature milk). Lipids provide half of the energy of human milk with the highest percentage of milk fat derived from triglycerides.[3,11] Fat content may vary considerably from mother to mother and may vary across the day as well as within a feeding. Maternal body mass index, maternal age, gestational age, parity, duration and number of breastfeeds per day along with stage of lactation have been identified as impacting lipid content.[4] Fat content is lowest in foremilk and at least double in hindmilk.[3,22] Overall, the energy ranges from 20.9 to 26.2 kcal per oz or 65 to 75 kcal/dL.

Effect of Maternal Diet on Fat Composition

Although the amount of human milk fat does not vary according to maternal diet,[23] the fatty acid profile of human milk reflects variation in the mother's dietary fatty acid intake during pregnancy and postpartum.[24] When a mother is losing weight, the fatty acid profile of her mobilized fat stores is reflected in the milk.[25] When mothers eat very low fat diets with adequate calories from carbohydrate and protein, more medium-chain fatty acids are synthesized in the breast.

DHA DHA is essential for retinal development and accumulates during the last months of pregnancy. The advantages of human milk seem particularly important to premature infants born before 37 weeks, perhaps because the concentrations of DHA are higher in the milk of mothers delivering preterm infants as compared to full-term infants.[26]

Milk DHA levels are influenced by maternal fat intake, supplementation, and fat stores.[22,27] The Federal Drug Administration (FDA) provides guidance on fish consumption for breastfeeding women that recognizes both the nutrients in fish and the potential for heavy metal contamination (www.fda.gov/fishadvice). Supplementation with cod liver oil, a good source of DHA, during pregnancy was associated with higher IQ scores at 4 years of age in breastfed versus HMS-fed infants.[28] Cod liver oil contains high levels of DHA as well as high levels of vitamins A and D, so it should be used with caution.

***Trans* Fatty Acids** *Trans* fatty acids stemming from the mother's diet are present in human milk.[29] *Trans* fat concentrations used to be similar in American and Canadian women, but lower in the milk of women from European and African countries. The reduction of *trans* fatty acids from food products in Canada has led to progressively lower levels of *trans* fat in human milk.[29] A similar reduction is expected in the United States since the FDA ban on artificial *trans* fats in 2015.

Cholesterol Cholesterol, an essential component of all cell membranes, is needed for growth and replication of cells. Cholesterol concentration ranges from 6.5 to 18.5 mg/100 mL[30] and varies between women, and from day to day within women.[30,31] Changes in maternal diet do not impact cholesterol levels in human milk. Breastfed infants

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have higher intakes of cholesterol and higher levels of serum cholesterol than infants fed HMS.[32] Levels of cholesterol do not differ between breastfed and HMS fed infants by 18 months of age. Adults who were breastfed as infants are more likely to have lower cholesterol concentrations compared to those who were fed HMS.[4]

Protein

The protein content of mature human milk is relatively low (0.8–1.0 percent) compared to other mammalian milks, such as cow's milk (Table 6.4). The concentration of proteins synthesized in the breast are more affected by the age of the infant (time since delivery) than maternal intake and maternal serum proteins. Proteins synthesized by the breast are more variable because hormones that regulate gene expression and guide protein synthesis change with time.[33] Despite the relatively low concentration, human milk proteins have important nutritive and nonnutritive values. Proteins and their digestive products, such as peptides, exhibit a variety of antiviral and antimicrobial effects.[34] Enzymes present in human milk might also provide protection by facilitating actions that prevent inflammation. The two main classes of milk proteins are casein and whey. The third class of milk proteins are mucins. Mucins are located in the milk fat globule membrane (MFGM) and play an important antiviral and antimicrobial role.[33]

Casein Casein, calcium phosphate, and other ions such as magnesium and citrate appear as an aggregate and are the source of milk's white appearance.[33,35,36] Casein's digestive products, casein phosphopeptides, keep calcium in soluble form and facilitate its absorption. Casein concentrations in early lactation are low and increase rapidly.

Whey Proteins Whey proteins are the proteins that remain soluble in water after casein is precipitated from milk by acid or enzymes. These proteins are highest in early lactation and decrease gradually during lactation. In early lactation, the whey:casein ratio is 90:10. This ration changes in mature milk to 60:40 and again in late lactation to 50:50.[3,4] Studies show the ratios have an impact on glucose metabolism and hormone release.[37] Whey proteins include milk and serum proteins, lysozyme, and immunoglobulins, among others. Lysozyme increases during lactation providing anti-inflammatory properties and protection against bacteria specifically *Escherichia coli* (*E. coli*) and some Salmonella strains.[4] Several mineral-, hormone-, or vitamin-binding proteins are also identified as components of whey proteins. These include lactoferrin, which carries iron in a form that is easy to absorb and can inhibit bacterial growth. The enzymes present in whey proteins aid in digestion and protection against bacteria and diarrheal diseases.

Mucins A type of milk protein found in the milk fat globule membrane (MFGM) **Nonprotein Nitrogen** Nonprotein nitrogen provides 20–25 percent of the nitrogen in milk.[14]

Urea accounts for 30–50 percent of nonprotein nitrogen, and nucleotides for 20 percent, depending on the stage of lactation and the eating patterns of the mother. Some of this nitrogen is available for the infant to use for producing nonessential amino acids. Some of the nonprotein nitrogen is used to produce other proteins with biological roles such as hormones, growth factors, free amino acids, nucleic acids, nucleotides, and carnitine. The nutritive and nonnutritive role of nonprotein molecules including nucleotides have been studied extensively. Nucleotides are now known to play an important role in immune function growth, maturation and repair of the gastrointestinal tract, and disease resistance.[3,4,12]

Milk Carbohydrates

Lactose is the dominant carbohydrate in human milk. Other carbohydrates—including monosaccharides (such as glucose), polysaccharides, oligosaccharides, and protein-bound carbohydrates—are also present.[38] Lactose enhances calcium absorption. As the second largest carbohydrate component, oligosaccharides contribute calories at low **osmolality**, stimulate the growth of *bifidus* bacteria in the gut, and inhibit the growth of *E. coli* and other potentially harmful bacteria.

Oligosaccharides **Human milk oligosaccharides (HMOs)** are medium-length carbohydrates containing lactose on one end. HMOs can be free, or bound to proteins as glycoproteins, or bound to lipids as glycolipids, or they can bind to other structures. The conjugated and unconjugated oligosaccharides are classified as glycans. Over 200 different HMOs are present as functional ingredients of human milk.[15,39,40] HMOs promote growth of beneficial bacteria are not digestible by bacteria in the digestive tract, enabling them to prevent the binding of pathogenic microorganisms to the surface receptors of their target cell preventing infection.[4,12] Accordingly, oligosaccharides in human milk can be considered part of the innate immune protection provided by breastfeeding.[41]

Fat-Soluble Vitamins

Vitamin A Colostrum has approximately twice the concentration of vitamin A as mature milk does. Some of the vitamin A in human milk is in the form of beta-carotene. Its presence is responsible for the characteristic yellow color of colostrum. The amount of vitamin A in mature

osmolality A measure of the concentration of particles in solution.

human milk oligosaccharides (HMOs) Medium-length carbohydrates with nutritive and nonnutritive properties

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milk is adequate to meet infant needs for growth and development through 6 months of age.[42] Infants who are vitamin A deficient have increased risk of eye problems, infection, iron deficiency anemia, and growth failure. Although milk levels are influenced by maternal dietary intake, a Cochrane review of clinical trials of vitamin A supplementation failed to demonstrate mortality or morbidity benefit to women or their infant.[43]

Vitamin D Vitamin D plays an important role in calcium absorption and bone metabolism. Maternal vitamin D status mirrors vitamin D content in human milk. Deficiency occurs most in breastfed infants when mother is deficient in vitamin D and predisposes them to neonatal hypocalcemia and rickets. However, when maternal dietary intake of vitamin D is adequate, transport of vitamin D into human milk appears to be adequate to meet infant needs.[44,45] Most vitamin D in human milk is in the form of 25-OH_2 vitamin D and vitamin D_3. Maternal exposure to sunlight has been reported to increase the vitamin D_3 level in milk tenfold.[44–46] Research is ongoing to determine maternal vitamin D supplementation needed to ensure adequate maternal and infant vitamin D status when sunlight exposure is insufficient.[46,47]

Vitamin E Vitamin E is a potent antioxidant that helps protect cells from oxidative damage and is important for maintaining normal neurological structure and function. It is believed that level of total tocopherols in human milk is related to the milk's fat content (40 µg of vitamin E per gram of lipid[49]). Alpha-tocopherol concentration decreases from colostrum to transitional milk and to mature milk,[17] whereas beta and gamma tocopherols remain stable throughout each stage of lactation. The level of vitamin E present in human milk is adequate to meet the needs of full-term infants for muscle and red blood cell integrity. The levels of vitamin E in preterm milk are not considered adequate to meet the needs of preterm infants.[48,49]

Vitamin K Vitamin K is needed to support development of clotting factors and prevent bleeding in newborn infants. Approximately 5 percent of breastfed infants are at risk for vitamin K deficiency based on vitamin K–dependent clotting factors. Administration of intramuscular vitamin K at birth to prevent vitamin K deficiency bleeding has been recommended in the United States since 1961.[50] There are cases of vitamin K deficiency among exclusively breastfed infants who did not receive vitamin K at birth.

Water-Soluble Vitamins

Most water-soluble vitamins in human milk are responsive to the content of the maternal diet or vitamin status (thiamin, riboflavin, vitamin B_6, vitamin B_{12}, and choline).[51] Milk of well-nourished women in the United States provides these nutrients in quantities meeting the estimated needs for their infants.[52] Rarely, B_{12} deficiency resulting in long-term neurological deficits has been reported in infants whose mothers had poor vitamin B_{12} status relating to vegan diet or pernicious anemia.[53] Folate is bound to whey proteins in human milk; therefore, its content in milk is less influenced by maternal intake of these vitamins than are the other water-soluble vitamins.

Minerals in Human Milk

The minerals in human milk contribute substantially to the osmolality of human milk. **Monovalent ion** secretion is managed closely by the alveolar cells, in balance with lactose, to maintain the isosmotic composition of human milk.

Mineral content in milk is related to the growth rate of the offspring. The mineral content of human milk is much lower than the concentration in cow's milk and the milk of other animals whose offspring grow faster. With the exception of magnesium, the concentration of minerals decreases over the first four months postpartum. This decline in the mineral content of milk during the period of rapid growth is not what one would expect, but infant growth is well supported.[54] The lower mineral concentration of human milk is easier for the kidneys to handle. This reduced load on the kidneys is considered a significant benefit of human milk.

Bioavailability An important feature of several of the minerals (magnesium, calcium, iron, and zinc) in human milk is the packaging that makes them highly available (bioavailable) to the infant.[55] Packaging minerals so that the infant can use them efficiently also reduces the burden to the mother because less of the mineral is needed in the milk. For example, zinc is 49 percent available from human milk, but only 10 percent available from cow's milk and cow's milk-based HMS.[56]

Iron Exclusively breastfed infants have little risk of anemia,[4,57] despite the seemingly low concentration of iron in human milk, but duration of breastfeeding can affect the risk of anemia. Vitamin C and lactose in human milk promote iron absorption. Iron status in breastfed infants is maintained for up to 9 months at similar levels as formula-fed infants who receive iron supplementation.[4] One study suggests that infants who are exclusively breastfed for 6.5 months are less likely to be anemic than those nursed exclusively for 5.5 months.[58]

Zinc Human milk zinc is bound to protein and is highly available, in comparison to cow's milk and cow's milk–based HMS. Both the zinc intake (per kg) and the zinc requirements of infants decline after the first few months.[59] Human milk zinc levels are maintained even

monovalent ion An atom with an electrical charge of +1 or −1.

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in the face of low maternal zinc intake.[60] Rare cases of zinc deficiency, which appears as dermatitis or intractable diaper rash, have been noted in exclusively breastfed infants, however.[55] A defect in the mammary gland uptake of zinc has been described as the cause of low milk concentration when maternal serum zinc concentrations are normal. In these cases, infants respond to zinc supplementation.

Trace Minerals Trace minerals (copper, selenium, chromium, manganese, molybdenum, nickel, and fluorine) are present in the human body in small concentrations and are essential for growth and development. Less is known about trace minerals and infant health than about other nutrients. In general, however, the levels of trace minerals in human milk are not altered by the mother's diet or supplement use, excepting fluoride.[61] The Dietary Reference Intake (DRI) for fluoride is 0.1 mg daily for infants less than 6 months of age.[62] Fluoride provided in community water is safe for breastfeeding women and their infants. Most infants who live in areas with fluoridated water do not need an additional supplement.[63,64] When bottled or well water is the primary source, water with fluoride added should be purchased.

Taste of Human Milk

"... too full o' th' milk of human kindness to catch the nearest way."

—Shakespeare's *Macbeth*, Act I, Scene V

This line from William Shakespeare reflects the centuries-old belief that a breastfeeding woman's eating pattern influences the composition of her milk and has a long-lasting influence on the child. The flavor of human milk is an important taste experience for newborn infants, but flavor is often ignored when the benefits of human milk or its composition are considered. Human milk is slightly sweet[65] and it carries the flavors of compounds ingested, such as mint, garlic, vanilla, and alcohol.[66]

The transfer of flavor compounds appears to occur selectively and in relatively low amounts.[67] Infant responses to flavors in milk seem to depend on the length of time since the mother consumed the food, and the amount and frequency of the flavor that the mother consumed (new versus repeated exposure). Infants seem more interested in their mother's milk when flavors are new to them. Infants nursed at the breast longer if a flavor (garlic) was new to them than if the mother had taken garlic tablets for several days.[68] Thus, exposing infants to a variety of flavors in human milk may contribute to their interest in and consumption of human milk as well as their acceptance of new flavors in solid foods.[69] As well, the longer an infant was exclusively breastfeed the more she preferred an umami solution at 6 months.[70] Thus, breastfeeding duration may influence flavor preference at the onset of complementary feeding.

6.3 Benefits of Breastfeeding

Breastfeeding Benefits for Mothers

Breastfeeding women experience hormonal, physical, and psychosocial benefits.[71] Breastfeeding immediately increases levels of oxytocin, a hormone that stimulates uterine contractions, minimizes maternal postpartum blood loss, and helps the uterus to return to nonpregnant size.

After the birth, the return of fertility (through monthly ovulation) is delayed in most women during breastfeeding, particularly with exclusive breastfeeding. This delay in ovulation results in longer intervals between pregnancies. Breastfeeding alone, however, is not as effective as other available birth control methods. Consequently, many health-care professionals in the United States do not promote breastfeeding as an option for birth control.

Many women experience psychological benefits, including increased self-confidence and facilitated bonding with their infants.[72] Additional short-term maternal health benefits to breastfeeding include less postpartum blood loss and a more rapid involution of the uterus.[73] Many still consider faster return to prepregnancy weight a benefit of breastfeeding; however, women may lose or gain weight while nursing. The impact of breastfeeding on maternal weight is discussed in more detail later in this chapter. In addition to these short-term benefits, women who nurse at a younger age and for longer duration may have lower risk of breast, endometrium and ovarian cancers,[71] rheumatoid arthritis,[73] diabetes, metabolic syndrome, hyperlipidemia, stroke and cardiovascular disease.[74]

Breastfeeding Benefits for Infants

"Breastfeeding—the main source of active and passive immunity in the vulnerable early months and years of life—is considered to be the most effective preventive means of reducing the death rate of children under five."

—M. H. Labbok, D. Clark, and A. S. Goldman[75]

Nutritional Benefits The value of the composition of human milk is widely recognized. Companies that make HMS often use human milk as the standard, recognizing the many unique properties of human milk:

- With its dynamic composition and the appropriate balance of nutrients, human milk provides optimal nutrition to the infant.
- The balance of nutrients in human milk matches human infant requirements for growth and development closely; no other animal milk or HMS meets infant needs as well.
- Human milk is isosmotic (of similar ion concentration; in this case, human milk and plasma are

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of similar ion concentration) and therefore meets the requirements for infants without other forms of food or water.

- The relatively low protein content of breast milk compared to cow's milk meets the infant's needs without overloading the immature kidneys with nitrogen.
- Whey protein in human milk forms a soft, easily digestible curd.
- Human milk provides generous amounts of lipids in the form of essential fatty acids, saturated fatty acids, medium-chain triglycerides, and cholesterol.
- Long-chain polyunsaturated fatty acids, especially docosahexaenoic acid (DHA), which promotes optimal development of the central nervous system, are present in human milk but are present in only some of the HMS marketed in the United States.
- Minerals in breast milk are largely protein bound and balanced to enhance their availability and meet infant needs with minimal demand on maternal reserves.

Immunological Benefits One of the most important realizations about breastfeeding is that human milk contains bioactive and immunologic components promoting development of the infant's immune system and providing protection against infection. Cells (T- and B-lymphocytes), secretory immunoglobins (sIgA, sIgG, sIgM, sIgE, sIgD), histocompatibility antigens, T-cell products, many nonspecific factors (complement, bifidus factor), carrier proteins (lactoferrin, transferring, vitamin B_{12}-binding protein, and corticoid-binding protein), and enzymes (lysozyme, lipoprotein lipase, leukocyte enzymes) are components of milk that confer immunological benefits. Studies are in process looking at these antiviral protein components especially lactoferrin related to activity against SARS-CoV-2 infection.

Cellular components in human milk (**macrophages**, **neutrophils**, **T-** and **B-lymphocytes**, and **epithelial cells**) are especially high in colostrum but are also present for months in mature human milk in lower concentrations. The function of macrophages in human milk includes phagocytosis of fungi and bacteria, killing of bacteria, and production of the complement proteins, lysozyme, and lactoferrin and immunoglobin A and G.[3,7,8]

Leukocyte function appears to offer more protection to the breast than to immunocompetence of the infant. Neutrophils, however, appear to be activated and contribute to phagocytosis at the mucosa of the infant's gastrointestinal tract.[76] Both T- and B-lymphocytes provide the infant with protection against organisms in the gastrointestinal tract. This protection may extend beyond acute infection to allergy, necrotizing enterocolitis, tuberculosis, and neonatal meningitis.[3,7,8]

Immunoglobins are transported from maternal plasma across secretory epithelium to become secretory immunoglobins. The predominant (90 percent) immunoglobulin in human milk, **secretory immunoglobin A (sIgA)**, also appears to be most important in terms of the protection conferred to the infant. Immunoglobins sIgA and sIgM protect the infant by blocking colonization with pathogens and limiting the number of antigens that cross the mucosal barrier. sIgA protects against enteroviruses, cytomegalovirus, herpes simplex virus, respiratory syncytial virus, rubella, retrovirus, and rotavirus[3,7,8] and sIgM protects against cytomegalovirus, respiratory syncytial virus, and rubella.

Bifidus factor is a growth factor (probably a carbohydrate) that supports growth of beneficial bacteria including *Lactobacillus bifidus*. *Lactobacillus* is a probiotic bacterium that stimulates antibody production and enhances phagocytosis of antigens.[3,7] The bifidus factor in combination with low phosphate and protein levels in human milk promotes an acid environment that discourages growth of some bacteria including some *E. coli, Salmonella*, and *Shigella*.[4]

Lysozyme protects against enterobacteria and other gram-positive bacteria. It may work together with lactoferrin to select out or destroy strains of gram-positive bacteria.[4] Lysozyme is secreted by neutrophils and macrophages.

Binding proteins in human milk bind iron and vitamin B_{12}, making the nutrients unavailable for pathogens to grow in the infant's gastrointestinal tract. Such factors are also responsible for some of the differences in intestinal flora (natural bacteria of the gastrointestinal tract) of breastfed infants versus HMS-fed infants.

Individual fatty acids and other milk components (oligosaccharides, gangliosides, and glycoconjugates) resulting from digestion of human milk are antimicrobial.[77] The digestive products of triacylglycerides and the lipid globule appear to protect against *E. coli* 0157:H7, *Campylobacter jejuni*, *Listeria monocytogenes*, and *Clostridium perfringens*.[78] Monoacylglycerides are able to lyse enveloped viruses, bacteria, and protozoa. Glycoconjugates (glycoproteins, glycolipids, glycoaminoglycans, and oligosaccharides) may bind pathogens directly, thus

macrophages A white blood cell that acts mainly through phagocytosis.

neutrophils Class of white blood cells that are involved in the protection against infection.

T-lymphocyte A white blood cell that is active in fighting infection. (May also be called T-cell; the T in T-cell stands for thymus.) These cells coordinate the immune system by secreting hormones that act on other cells.

B-lymphocytes White blood cells that are responsible for producing immunoglobulins.

epithelial cells Cells that line the surface of the body.

secretory immunoglobin A (sIgA) A protein found in secretions that protect the body's mucosal surfaces from infections. The mode of action may be by reducing the binding of a microorganism with cells lining the digestive tract. It is present in human colostrum but not transferred across the placenta.

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preventing infection. Nucleotides are reported to increase resistance to *Staphylococcus aureus* and *Candida albicans* and may increase response to vaccine antigens.[79]

Growth factors and hormones in human milk, such as insulin, enhance the maturation of the infant's gastrointestinal tract. These substances also help protect the infant, especially neonates, against viral and bacterial pathogens.

Lower Infant Mortality Breastfeeding and providing human milk to infants saves lives. Infant loss is traumatic and takes a toll on the mother and the entire family. Infant loss is viewed differently around the globe due to differences in societal and cultural attitudes and has the potential to increase mental health conditions. In the developing world, improving breastfeeding practices could prevent more than 1 million deaths annually. This protection of lives is at the center of the WHO's and UNICEF's joint effort, called the Global Strategy for Infant and Young Child Feeding, to remind the international community of the impact of feeding practices (including breastfeeding) on children's health outcomes.[80]

Breastfeeding to any duration and to any extent reduces the risk of sudden infant death syndrome (SIDS).[81] A meta-analysis of 18 studies demonstrated a 60 percent reduction in risk of SIDS with any level of breastfeeding, although the influence was greater with exclusive breastfeeding and greater duration. This analysis suggests that breastfeeding was an independent factor associated with reduction in risk. These results are consistent with the American Academy of Pediatrics' recommendation of breastfeeding exclusively for 4–6 months where no contraindications are present.[82]

Fewer Acute Illnesses Breastfeeding reduces infant illness in countries with high infant illness (**morbidity**) and death (**mortality**) rates, poor sanitation, and questionable water supplies. Even in the United States and other developed nations, where modern health-care systems, safe water, and proper sanitation are commonplace, there is a clear relationship between breastfeeding and reduced rates of illness in infants. Exclusive breastfeeding for four months is associated with reduced gastrointestinal illness with effects lasting for 2 months after weaning.[82] Ear infections are 23 percent lower, with a reduction in risk of 50 percent for infants breastfed longer than 3 months. The risk of hospitalization for lower respiratory infections is 72 percent lower among infants exclusively breastfeed for more than 4 months when compared to infants fed HMS. These results support the current public health recommendations for breastfeeding.

morbidity The rate of illnesses in a population.
mortality Rate of death.
cognitive function The process of thinking.

Reductions in Chronic Illness In addition to the lower rate of acute illnesses in breastfed children, breastfeeding also seems to protect against chronic childhood diseases including celiac disease, inflammatory bowel disease, diabetes, and leukemia.[82] Risk of asthma, atopic dermatitis, and eczema is reduced among infants with a family history who are breastfed for 3–4 months.[83,84]

Breastfeeding and Childhood Weight Considerable attention has been paid to the role of breastfeeding in preventing obesity, but this relationship is still a topic of active investigation. Breastfed infants typically are leaner than HMS-fed infants at 1 year of age without any difference in activity level or development.[84,85] Several potential mechanisms have been identified for the modest reduction in obesity in children who were breastfed, including metabolic programming, possibly related to leptin, ghrelin, and other neurometabolic messengers delivered in human milk.[86,87] Other contributors could include learned self-regulation of energy intake and other characteristics of the families or parents, such as healthy lifestyle. Accordingly, the influence of breastfeeding usually disappears by age 5.

Cognitive Benefits **Breastfeeding**, and especially duration of breastfeeding, is associated with cognitive benefits, assessed by intelligence quotient (IQ).[82] The increases in cognitive ability associated with breastfeeding are significant even after adjusting for family environment.[86] A randomized study comparing breastfed infants to those fed cows' milk and soy milk–based HMS found all groups scored within normal ranges, but breastfed infants scored slightly higher. In addition, higher IQ of infants breastfed for 6 months appears to be more prevalent among infants born small for gestational age (11 points) than among infants born appropriate weight for age (3 points).[87,88] The differences in **cognitive function** are also greater in premature infants fed human milk than in those fed HMS.[9,87,88] Recognition that the fatty acid composition of milk plays an important role in neuropsychological development bolsters the credibility of psychological or cognitive benefits from breastfeeding.

Analgesic Effects Breastfeeding seems to work as an analgesic in infants. Breastfeeding during venipuncture seems to reduce infant pain as well as a 30 percent glucose solution followed by pacifier use.[89] Breastfeeding may be used to comfort infants during minor invasive procedures.[90]

Benefits

The economic cost of not breastfeeding is staggering. A decrease in medical care for breastfed infants is the primary socioeconomic benefit of breastfeeding. A 2010 study estimated that the United States could have saved $13 billion and 911 lives, mostly infants, if 90 percent of infants were breastfed.[91] This estimate was based on the breastfeeding-related reduction in necrotizing

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enterocolitis, otitis media, gastroenteritis, hospitalization for lower respiratory tract infections, atopic dermatitis, SIDS, childhood asthma, childhood leukemia, type 1 diabetes mellitus, and children with obesity. In Louisiana alone, the estimate of savings was in excess of $216 million and 18 lives if 90 percent of infants in that state were breastfed.[92] Companies benefit through lower medical costs and greater employee productivity. A $1 investment in creating a lactation support program provides two to three times the return.[93] More recent studies show similar results to this 2010 study supporting breastfeeding as one of the most important interventions for reducing mortality in children under 5 years of age.[94]

6.4 Breast Milk Supply and Demand

Establishing a Good Milk Supply in the First Month

Putting the baby to breast within the first half hour or as quickly as possible after birth is a first important step to a good milk supply. Encourage rooming in so that women/lactating persons can feed frequently (10–12 times in 24 hours) in the first days. Provide women/lactating parent with a breast pump if she is separated from her infant. Lactation support should be provided so that women and all lactating persons learn how to position the infant comfortably and recognize effective nutritive feeding (long drawing motion along the jaw and wiggling at the temple). Encourage women and lactating persons to stay hydrated by having water or other liquids nearby when they nurse. Encourage women and all lactating persons to eat well, with a diet rich in vegetables, fruits, whole grains, and lean protein sources. Feeding the baby from both breasts is important. Allow the baby to nurse for comfort in the first weeks, by putting the baby to breast whenever she fusses. If the baby favors one breast, start at the favored breast and switch to the other breast when the baby's sucking slows down. Allowing for skin-to-skin contact can help the infant nurse longer.

Can Women Make Enough Milk?

Typical milk production averages approximately 600 mL (240 mL = 1 cup, or 8 oz) in the first month postpartum and continues to increase to approximately 750–800 mL per day by 4–5 months' postpartum.[20,95] Milk production can range from 450 to 1,200 mL per day in women who are nursing one infant.[20] Infant weight, the caloric density of milk, and the infant's age contribute significantly to the infant demand for milk. Milk increases to meet the demand of twins, triplets, or infants and toddlers suckling simultaneously; it can also be increased by pumping the milk.[96]

Traditionally, factors such as how vigorously an infant nurses, how much time the infant is at the breast, and how many times he or she nurses in a day were thought to control milk production. We now know that milk synthesis (rate of accumulation of milk in the breast) is related to infant demand.[97-99] That is, the removal of milk from the breast seems to be the signal to make more milk, and most women are able to increase their milk production to meet infant demand.[100]

An average of 24 percent of milk is left in the breast after feeding.[99] Thus, the short-term milk storage of the breast does not seem to be a limiting factor to infant milk intake. The average rate of synthesis in a day is only 64 percent of the highest rate of milk synthesis, suggesting that milk synthesis could be increased considerably. Comparisons of milk production between mothers of singletons and twins show that the breasts have the capacity to synthesize much more than a singleton infant usually drinks.[96]

Does the Size of the Breast Limit a Woman's Ability to Nurse Her Infant?

The size of a woman's breast does not determine the amount of milk production tissue (clusters of alveoli containing secretory cells that produce the milk).[98] Much of the variation in breast size is due to the amount of fat in the breast. The size of the breast does limit storage because of limitations in the expansion of the ducts. Daily milk production is not related to the total milk storage capacity within the breast, however. This means that women with small breasts can produce the same amount of milk as women with large breasts, although the latter woman may be able to feed her infant less frequently to deliver the same volume of milk compared with a woman with smaller breasts.[99]

Is Feeding Frequency Related to the Amount of Milk a Woman Can Make?

Feeding frequency is not consistently related to milk production. The rate of milk synthesis is highly variable between breasts and between feedings.[99] However, the amount of milk produced in 24 hours and the total milk withdrawn in that 24-hour period are highly related. Milk synthesis is able to quickly respond to infant demand.

The breast responds to the degree of emptying during a feeding, and this response is a link between maternal milk supply and infant demand. Daly proposed that the breast responds to the infant's need by measuring how completely the infant empties the breast.[99,100] For example, if a lot of milk is left in the breast, then milk synthesis will be low to prevent engorgement; if the breast is fully emptied, synthesis will be high to replenish the milk supply.

Exact mechanisms of milk supply and demand are not well understood, but they seem to be related to a protein called feedback inhibitor of lactation (FIL).[100] FIL is an active whey protein that inhibits milk secretion through an autocrine messaging mechanism. This protein inhibits all milk components equally according to their concentration in milk. Therefore, this protein seems to affect milk quantity only, not milk composition.

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Can Women Pump or Express Enough Milk?

Pumping or expressing milk may be needed for many reasons, including maternal or infant illness or separation.[101] Women can express milk using several different methods: manually, hand pumps, commercial electric pumps, or hospital-grade electric pumps. A pump that allows mothers to pump both breasts at the same time (10 minutes per session) can save time over single pumping (20 minutes per session).[102] Electric pumps are efficient and may increase prolactin more than hand expression or hand pumping.[102] Insufficient milk production is a common problem among women who express milk. Researchers working with women who pumped their breasts report that 8–12 or more milk expressions per day were necessary to stimulate an adequate production of milk. The optimal number of expressions in a 24-hour period is likely to differ for women according to how well they empty the breast and the storage capacity of the breast. Women who are able to establish an adequate volume of milk (500 mL per day) in the first 2 weeks' postpartum are more likely to still have enough milk for their infant at 4–5 weeks' postpartum. This recommendation is consistent with the advice to nurse the infant (or pump) early and often to build a good milk supply. Refer to the section in Chapter 7, "Human Milk Collection and Storage," for information on storage of milk.

Can Women Breastfeed after Breast Reduction or Augmentation Surgery?

Information regarding breastfeeding rates after breast surgery is scarce. Accumulating evidence does suggest that women who undergo breast reduction surgery may be at risk for unsuccessful lactation, as evidenced by lower breastfeeding rates and duration and greater perception of insufficient milk supply than among women without prior breast surgery. Almost all (91.8 percent) women with prior breast reduction surgery reported problems with breastfeeding.[103,104] The type of surgery, including the location and amount of breast tissue removed and the damage to remaining tissue, appears to be an important determinant of ability to breastfeed. Women may choose to have an incision around the lower part of the breast to avoid damage to the ductal system caused by incision in the midst of the breast. Women with periareolar (around the nipple) incisions experience greater difficulties with breastfeeding because of damage to the ductal system.[105] After augmentation surgery, compression of the ducts in the breast may lead to poor milk production. Lactation consultants recommend that the surgery date, type, and incision used, as well as prior breastfeeding experience be ascertained. Infants should be closely followed to prompt intervention when needed.

Breast implants are not a contraindication to breastfeeding. Nearly a million women in the United States have breast implants containing silicone. Early reports introduced concern of esophageal dysfunction in children of women who had silicone implants, but more recent research found no evidence to support such claims, and silicone concentrations in milk from women with implants are not elevated and, in fact, are lower than those in formula and cow's milk.[106] It is possible that immunological responses could cause unfavorable effects; however, there is no evidence suggesting direct toxicity to the infant. Therefore, the most likely influence on breastfeeding is similar to the effects of saline implants: compression of ducts leading to poor milk production.

6.5 The Breastfeeding Process

Preparing the Breast for Breastfeeding

Breasts and nipples begin to be sore in the first trimester of pregnancy, but the tenderness usually subsides by the end of the first trimester. Enlargement of the breast and nipple are evident by the end of the first trimester and continue through pregnancy. By the third trimester, Montgomery glands, sebaceous glands that produce oils to lubricate the nipple and areola, become pronounced and the nipples darken. Gentle massage is recommended by the La Leche League and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) programs to get women accustomed to handling their breasts and to prepare them for expressing milk. Women with flat or inverted nipples may be instructed on the Hoffman technique to break up adhesions. The thumbs are placed opposite each other at the base of the nipple and thumbs are simultaneously pressed in and away from each other. This procedure is repeated with the position of the thumbs varied around the nipple. Women should understand that breasts may leak milk prior to delivery. Anecdotal reports include milk leaking as early as 20 weeks of pregnancy.

Breastfeeding Positioning

Proper positioning of the infant at the breast is important to breastfeeding success. Mothers need to learn from health professionals experienced in optimal positioning, because improper positioning causes pain and possible damage to nipple and breast tissue.[107] The mother may need to use cushions, pillows, or a footstool to be comfortable and positioned well to nurse the infant (Figure 6.4).

Presenting the Breast to the Suckling Infant

Women use their hand to shape and position the breast so that the infant can easily latch. The grasp should allow the infant to place a sufficient amount of the areola into his or her mouth. For palmar grasp, the mother places her thumb above the areola, and remaining fingers are placed under the breast to form a *C* or *U*. A scissor grasp or V hold involves placement of her thumb and index finger above the areola with the remaining three fingers below, may also be used. It is important to note that the nipple is not

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Figure 6.4 Breastfeeding positioning.

tipped upward when the breast is presented to the infant to avoid improper latch-on and nipple abrasion. The mother or lactating persons should be encouraged to use the hand positioning to support the breast that is most comfortable.

Once the mother or lactating persons are comfortable, they should hold the baby close to their side with the baby's nose in line with the nipple and with the baby's mouth directly in front of the nipple. Stimulate the oral search reflex by touching the baby's bottom lip with the nipple which should be pointed toward the roof of the baby's mouth. Then the infant will open his or her mouth wide and should be brought to the breast with the nipple centered in the mouth (Figure 6.5). This process is called *latching on*. Infants who are properly attached at the breast have all or most of the areola in their mouth. If the mother pulls down the infant's lower lip, she should see the tongue lying around the lower gum line. The baby's nose should be close to the breast, with breathing unrestricted. The mother should hear swallowing, but not smacking, clicking, or slurping. Women who consistently have pain when the infant is suckling should consult a professional trained in lactation to correct the attachment position.[107] Infants who are positioned correctly at the breast start to suckle almost immediately, change from quick short sucks to slow deep sucks, and remain relaxed.

6.6 The Breastfeeding Infant

Infant Reflexes

Healthy-term infants are born with several reflexes that enable them to nourish themselves. Observations show that 18-week-old fetuses start sucking. By 34 weeks' gestation, the suck has adequate pace and rhythm to be nutritive. The gag reflex is the reflex that prevents taking food and fluids into the lungs. This reflex is developed by 28 weeks' gestation. These reflexes allow term infants to suck and swallow in a coordinated pattern that protects the airways.

Two other reflexes describe the infant's ability to position herself to breastfeed. The *oral search reflex* is described as the infant opening his or her mouth wide in proximity to the breast while thrusting the tongue forward. The *rooting reflex* results in the infant turning to the side when stimulated on the side of the upper or lower lip. Infants come forward, open their mouth, and extend the tongue when the center of either the upper or lower lip is stimulated.

The presence of these reflexes is important to the success of breastfeeding. However, successful nursing also requires appropriate positioning of the infant at the breast and adequate maternal letdown and milk production. Appropriate positioning and maternal assessment of infant nursing behaviors must be learned. Support from lactation consultants and/or other health-care professionals who are trained in lactation may be necessary.

Mechanics of Breastfeeding

During feeding, suction created within the baby's mouth causes the mother's nipple and areola to elongate and form a teat. The baby's jaw moves her tongue toward the areola, compressing it and causing milk to travel from the milk ducts to the infant's mouth. The baby then raises the anterior portion of the tongue to complete the process. Afterward, the baby depresses and retracts the posterior portion of her tongue in peristaltic motions, forming a groove in the tongue that channels milk to the back of the oral cavity. This backward movement of the tongue creates a negative pressure, allowing milk to be delivered into the baby's mouth. Receptors in the back of the oral cavity are stimulated and initiate the swallowing reflex. A correctly placed nipple does not move in the baby's mouth during suckling.

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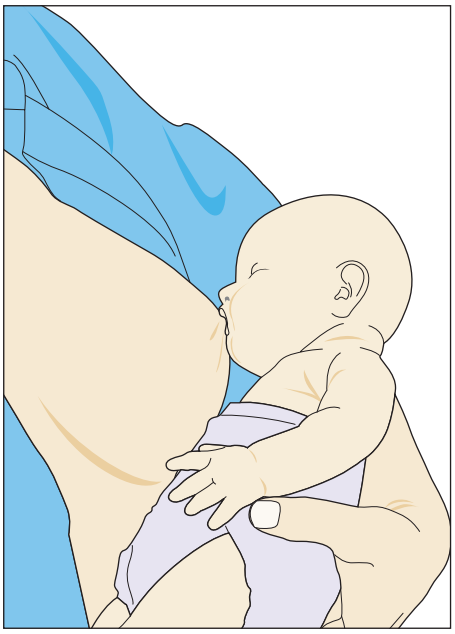
a. Touching the baby's bottom lip with the nipple stimulates the oral search reflex.



b. The infant opens his mouth wide.



c. The infant is brought to the breast with the nipple centered in his mouth.



d. The infant is properly latched at the breast and has all of the areola in his mouth.

Figure 6.5 Attachment.

Identifying Hunger and Satiety

When infants are hungry, they show hunger cues and begin to bring their hands to their mouth, suck on them, and start moving their head from side to side with their mouth open (rooting reflex). Infants should be fed when these signs of hunger are displayed rather than waiting for crying, a late sign of hunger. Recognizing early hunger behaviors and initiating feeding before the infant becomes very upset helps mothers and infants who have difficulty nursing.

Nutritive and nonnutritive sucks are different. Feedings begin with nonnutritive sucking. The infant sucks quickly and not particularly rhythmically. Nutritive sucking is slower and more rhythmic as the infant begins to suck and swallow. A mother can hear the infant suck in a quiet room.

Infants should be allowed to nurse as long as they want at one breast. Infants who are fed for shorter periods from both breasts can get larger amounts of foremilk. The high lactose content of foremilk can cause diarrhea and bright-green colored stools.[108] Allowing the infant to nurse at one breast until satisfied creates a pattern that assures that the infant gets both foremilk and hindmilk. Infants who fall asleep before they empty the breast can be kept awake by gently tickling the feet, rubbing the head, and talking to the baby.

The higher fat content of hindmilk may help in signaling satiety. Infants will stop nursing when full. If they are still hungry, after burping, they can be offered the other breast.

Feeding Frequency

Stomach emptying occurs in about 1½ hours for breastfed infants. Ten to 12 feedings per day are normal for newborn infants. Different feeding patterns can meet infant needs. In one study, infants who did not feed from midnight through early morning consumed more in the other feedings, particularly in the morning. Milk intake and weight gain of these infants in the first 4 months of life were similar to those of infants whose feedings were distributed over 24 hours (Case Study 6.1).[109]

Identifying Breastfeeding Malnutrition

Newborn weight loss is common. Evaluation to identify and correct potential problems is needed if weight loss is $>$ 5 percent. Weight loss of up to 7 percent can occur in the first 5 days, but this percent is the maximum weight loss that should occur.[82] Malnourished infants become sleepy and nonresponsive, and they have a weak cry and few wet

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Case Study 6.1 Breastfeeding and Adequate Nourishment

Mabel. is a 24-year-old office manager and part-time aerobics instructor who has delivered vaginally, without complications, a healthy, full-term son, Donovan. With a birthweight of 3,200 g (7 lb), Donovan is the first child for Mabel and her husband. Mabel is 162 cm (5 ft 4 in.) tall with a prepregnancy weight of 56.8 kg (125 lb). She gained 25 kg (55 lb) during her uncomplicated pregnancy and has been a lacto-ovo vegetarian for 5 years. After a 12-hour stay in a birthing center, Mabel and her husband bring Donovan home.

At 4 days' postpartum, Mabel, her husband, and her mother-in-law bring the baby to the health-care clinic for his first follow-up visit. Mabel and her husband are very concerned about whether their son is getting adequate nourishment, so the dietitian is called to see the family. During nutrition assessment, the following information is documented. Donovan weighs 3,000 g (6 lb 6 oz). The parents report that Donovan nurses vigorously about every 1½ to 2 hours and never sleeps for more than a couple of hours. Mabel says that her milk "came in" on the second postpartum day and that she feels like all she does is nurse. Her nipples are tender, but not uncomfortably sore. She reports that Donovan has at least six to eight wet diapers and two to three very loose stools each day. She wonders if she has enough milk and worries about how she will ever return to work in 2 months. She also wants to lose the excess weight she gained during the pregnancy and is eager to return to her aerobics classes. Her husband and mother-in-law are supportive, but they worry about the baby.

The dietitian's nutrition assessment of the infant concludes that Donovan is a healthy infant with no nutritional problems. The family is referred to their pediatrician for further follow-up.

Questions

1. What factors put Mabel at high risk for early termination of breastfeeding?
2. What factors indicate that Donovan is getting adequate nourishment?
3. What concerns do you have about Mabel's diet? What advice would you give her about her weight-loss plans and eagerness to return to exercise? Do Mabel or Donovan need any vitamin/mineral supplements?
4. If Mabel lived in your community, what resources would be available for help and support for breastfeeding mothers?
5. What steps can Mabel take to continue successful breastfeeding when she returns to work in 2 months?

(Answers are located in the Instructor's Manual for the 8th edition of *Nutrition Through the Life Cycle*.)



LWA/Dann Tardif/Blend Images/Getty Images

diapers. By the fifth to seventh day postpartum, infants who are getting adequate nourishment (8–12 feedings per day) have wet diapers approximately six times a day and have three to four soft, yellowish stools per day. Their urine is pale yellow and dilute, while stools are loose and seedy (some small particles are present in the stool). Infants who are slow gainers and not malnourished are alert, bright, responsive, and develop normally. In contrast, infants who are failing to thrive are apathetic, hard to arouse, and have a weak cry. They have few wet diapers, and their urine is concentrated. Their stools are infrequent.

Mothers of slow-gaining infants in particular should be advised to let the infant nurse at one breast until it is empty or the infant stops nursing, rather than switching breasts after a specific amount of time. This regimen assures that the infant gets hindmilk with a higher fat and calorie content.

Tooth Decay

Human milk has infection-fighting components that inhibit the formation of dental caries. Nevertheless, caries can occur in children who are breastfed.[110,111] Frequent nursing at night after 1 year of age is a risk factor for dental caries. Nevertheless, the prevention of dental caries is not justification for advising early weaning. Rather, the mother should be instructed on the prevention and treatment of early childhood dental caries. All children should be seen by a qualified dentist 6 months after the first tooth erupts or by 12 months of age. Mothers are the primary source of bacteria that cause early childhood caries. Therefore, mothers or primary caregivers should be given information on oral hygiene, diet, fluoride, caries removal, and prevention of caries.

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Breastfed babies may have straighter teeth due to the development of a well-rounded dental arch.[111] A well-rounded arch may also help prevent sleep apnea later in life.

Vitamin Supplements for Breastfeeding Infants

All infants, whether they are fed human milk or HMS, are vulnerable to vitamin K–deficiency bleeding (VKDB). All infants in the United States receive a vitamin K supplement (0.5–1.0 mg by injection) at birth because it is known to decrease the risk of VKDB.[112]

Exclusively breastfed infants should be given a supplement of 400 IU of vitamin D per day beginning in the first 2 months of life.[113–115] A minimum intake of 600 IU of vitamin D supplementation should be achieved by age 1 and maintained.[115]

Routine fluoride supplements are not needed by breastfed infants during the first six months of life.[61,82] After 6 months, the decision to supplement with fluoride should be made based on individual situations. If the water, food, and toothpaste contain less than 0.3 ppm fluoride, then supplemental fluoride is recommended. When supplementation is indicated for breastfed infants, maternal supplementation may be the best route.

Breastfed infants born at term do not need iron-fortified HMS or supplements because they rarely experience iron deficiency.[82] The excess iron in HMS might bind with lactoferrin in human milk, resulting in a loss of the protective activity of lactoferrin.

6.7 Maternal Diet

The U.S. Dietary Guidelines recommendations on healthy eating patterns (presented in Chapter 1) have been adapted for pregnant and breastfeeding women. The Dietary Guidelines indicate that moderate weight reduction can be achieved by the breastfeeding mother without compromising the weight gain of the nursing infant by consuming a healthy variety of foods.[116]

Healthy eating patterns formed around healthy dietary patterns for pregnant and breastfeeding women provide a healthy assortment of nutrients at specified caloric levels appropriate for the stage of breastfeeding (Figure 6.6).

Nutrition Assessment of Breastfeeding Women

Nutrition assessment for adults is outlined in Table 2.10. Assessment for breastfeeding women includes similar parameters, with a focus on commonly encountered problems, delineated in Table 6.5. Attention should be paid to appropriate maternal energy intake to achieve or maintain ideal or healthy target maternal body weight. Specific foods that may be related to infant colic may need to be avoided among women whose infants exhibit symptoms. A careful history of food and supplement use, as well as physical activity, and pertinent medical and breast health history are obtained. Common diagnoses include altered

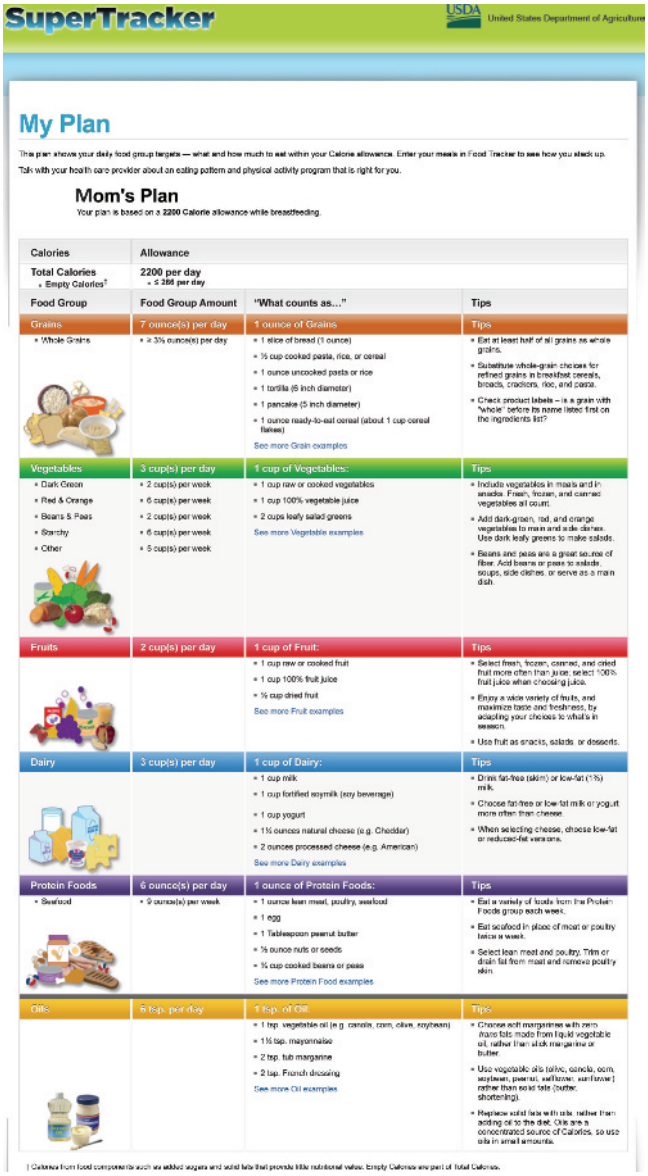


Figure 6.6 Daily Food Plan for Moms menu planning resource.

maternal weight status, concern for inadequate milk supply, and need for B_{12} supplement for vegan dietary pattern. Lack of knowledge related to dieting and breastfeeding and qualifications for The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) services are also common. Nutrition intervention may include a plan for adjusting energy intake to promote appropriate maternal weight change, education regarding milk production mechanisms and appropriate maternal feeding and/or pumping to achieve appropriate supply, and/or alternate food sources or supplement recommendations for nutrient deficiency or inadequate intake of nutrients such as calcium or vitamin B_{12}. A plan for monitoring maternal weight change, infant growth (adequate milk supply), or nutrient status rounds out the nutrition assessment process.

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Table 6.5 Summary of the components of the four steps of the Nutrition Care Process for Breastfeeding Women (Academy of Nutrition and Dietetics)

Step 1. Nutrition Assessment				
Food/Nutrition Related History	**Anthropometric Measurements**	**Biochemical Data, Medical Tests, and Procedures**	**Nutrition-Focused Physical Findings**	**Client History**
• Diet history • Foods that may increase infant colic • Adequate energy to achieve healthy weight • Prenatal vitamin (folic acid and iron)	• Prepregnancy weight • Current weight • Weight gain for stage of pregnancy	• Hemoglobin/hematocrit • Glucose tolerance test	• Nausea/vomiting • Weight gain	• Medical history, treatments (breast surgeries), use of alternative/complementary medicine, social history • Medications/herbal supplements • Exercise • Dieting

Step 2. Common Nutrition Diagnoses for Breastfeeding Women		
Intake	**Clinical**	**Behavioral-Environmental**
• Nutrient inadequacy or excess • Vegan • Lactose intolerance	• Inadequate milk production • Pica	• Food cravings • Food Insecurity • Need/qualify for WIC services

Step 3. Common Nutrition Interventions for Breastfeeding Women			
Food and/or Nutrient Delivery	**Nutrition Education**	**Nutrition Counseling**	**Coordination of Nutrition Care**
• Alter energy intake to achieve ideal weight or weight goal • Prenatal vitamin • Vitamin B_{12} • Iron supplement	• Educate on principles of milk production, early signs of infant hunger, and signs of adequate infant milk intake	• Establish food and exercise plan • Establish follow-up schedule	• Refer for WIC services

Step 4. Common Nutrition Monitoring and Evaluation Plan Components			
Food/Nutrition-Related History Outcomes	**Anthropometric Measurement Outcomes**	**Biochemical Data, Medical Tests, and Procedure Outcomes**	**Nutrition-Focused Physical Finding Outcomes**
• Change in diet to avoid infant colic	• Weight change • Infant growth	• Vitamin B_{12} status	• Maternal weight change • Infant growth

Energy and Nutrient Needs

The DRI for energy, updated in 2023, assume that the energy spent for exclusively breastfeeding 0–6 months is 540 kcal per day. Energy mobilization from stores of 140 kcal per day is subtracted at the end of the calculation. The estimated energy requirements (EER) are calculated by determining the total energy expenditure (TEE) plus the energy cost of milk production minus the energy mobilization. Females 19 years and older who are breastfeeding should use the EER equations for women 19 years and above. For females less than 19 years of age who are breastfeeding, calculations to determine EER should use the equations for Girls <19 years old. Four levels of physical activity are used in the equations to determine EER (Table 6.6). For females partially breastfeeding 7–12 months postpartum, 380 kcal per day is assumed to be the energy cost of milk production. It is assumed that after 6 months postpartum, weight has stabilized (Table 6.7). For females who continue breastfeeding in the second year of lactation, the energy cost of milk production varies based on maternal factors and the total amount of milk produced. The DRI Energy committee notes in the lactation section that the EER equations are consistent with other weight gain guidelines from the IOM and NRC (2009) when using calculations with the TEE that include the additional energy cost of milk production during lactation.[116-119]

The 2020–2025 DRI is 330 additional kcal to support 0.8 kg per month weight loss (170 cal per day) for the first 6 months and 400 kcal per day afterward. With mobilization of approximately 170 kcal per day, net energy needs were estimated at approximately 450 kcal per day.

We now understand that women use several mechanisms to meet the energy needs of lactation. Adjustments in energy intake and energy expenditure must be balanced to meet those needs. Goldberg et al.[120] found that women increased food intake (56 percent of the need for milk production) and decreased physical activity (44 percent of the energy need for milk production) to meet the increase in energy needs for lactation. Doubly labeled water studies suggest that the components of energy expenditure vary greatly, and measurements of dietary intake can be unreliable. Therefore, a single recommendation for energy for lactating women could never address all of the individual ways that women meet their energy needs. Assessment of adequacy of energy

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Table 6.6 Summary Table of EER Equations for Women and Girls Exclusively Breastfeeding 0 to 6 Months Postpartum

Age Group	PAL Category	EER Equation (kcal/day)
Women, 19 years and above	Inactive	EER = 584.90 − (7.01 × age) + (5.72 × height) + (11.71 × weight) + energy cost of milk production − energy mobilization
	Low active	EER = 575.77 − (7.01 × age) + (6.60 × height) + (12.14 × weight) + energy cost of milk production − energy mobilization
	Active	EER = 710.25 − (7.01 × age) + (6.54 × height) + (12.34 × weight) + energy cost of milk production − energy mobilization
	Very active	EER = 511.83 − (7.01 × age) + (9.07 × height) + (12.56 × weight) + energy coat of milk production − energy mobilization
Girls, <19 years	Inactive	EER = 55.59 − (22.25 × age) + (8.43 × height) + (17.07 × weight) + energy cost of milk production − energy mobilization
	Low active	EER = −297.54 − (22.25 × age) + (12.77 × height) + (14.73 × weight) + energy cost of milk production − energy mobilization
	Active	EER = −189.55 − (22.25 × age) + (11.74 × height) + (18.34 × weight) + energy cost of milk production − energy mobilization
	Very active	EER = −709.59 − (22.25 × age) + (18.22 × height) + (14.25 × weight) + energy cost of milk production − energy mobilization

Notes: For exclusively breastfeeding 0–6 months postpartum: EER (kcal/d) = TEE (kcal/d) + energy cost of milk production (kcal/d) − energy mobilization (kcal/d). Energy cost of milk production estimated for women and girls exclusively breastfeeding 0–6 months postpartum: **540 kcal/d**. Energy mobilization estimated for women and girls exclusively breastfeeding 0 to 6 months postpartum: 140 kcal/d. EERs are in kilocalories/day, age is in years, height is in centimeters, weight is in kilograms, energy cost of milk production is in kilocalories/day, and energy mobilization is in kilocalories/day.

intake of breastfeeding women should always be made within the context of the mother's overall nutritional status and weight changes and the adequacy of the infant's growth.

Maternal Energy Balance and Milk Composition

The composition of breast milk depends on maternal nutritional status. Protein–calorie malnutrition results in an energy deficit that reduces the volume of milk produced but does not usually compromise the composition of the milk. Several studies show that milk production is maintained when there is a modest level of negative calorie balance. Animal models first identified a potential threshold effect of energy restriction. Baboons fed 60 percent of their voluntary intake significantly reduced milk production.[121] Yet, baboons fed 80 percent of their usual

Table 6.7 Summary Table of EER Equations for Women and Girls Partially Breastfeeding 7 to 12 Months Postpartum

Age Group	PAL Category	EER Equation (kcal/day)
Women, 19 years and above	Inactive	EER = 584.90 − (7.01 × age) + (5.72 × height) + (11.71 × weight) + energy cost of milk production
	Low active	EER = 575.77 − (7.01 × age) + (6.60 × height) + (12.14 × weight) + energy cost of milk production
	Active	EER = 710.25 − (7.01 × age) + (6.54 × height) + (12.34 × weight) + energy cost of milk production
	Very active	EER = 511.83 − (7.01 × age) + (9.07 × height) + (12.56 × weight) + energy coat of milk production
Girls, <19 years	Inactive	EER = 55.59 − (22.25 × age) + (8.43 × height) + (17.07 × weight) + energy cost of milk production
	Low active	EER = −297.54 − (22.25 × age) + (12.77 × height) + (14.73 × weight) + energy cost of milk production
	Active	EER = −189.55 − (22.25 × age) + (11.74 × height) + (18.34 × weight) + energy cost of milk production
	Very active	EER = −709.59 − (22.25 × age) + (18.22 × height) + (14.25 × weight) + energy cost of milk production

Notes: For partially breastfeeding 7–12 months postpartum: EER (kcal/d) = TEE (kcal/d) + energy cost of milk production (kcal/d). Energy cost of milk production estimated for women and girls partially breastfeeding 7–12 months postpartum: 380 kcal/d. EERs are in kilocalories/day, age is in years, height is in centimeters, weight is in kilograms, and energy cost of milk production is in kilocalories/day.

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intake maintained milk production. Randomized studies such as the one performed on baboons cannot ethically be done with humans. However, a series of human studies on weight loss during breastfeeding (discussed below) support a threshold effect of energy limitations on lactation.

Weight Loss During Breastfeeding

Current DRIs are written assuming a weight loss of 0.8 kg/month.[118,119] In addition, mechanisms that favor use of maternal fat stores and delivery of nutrients to the breast seem to occur during lactation. Despite these mechanisms that should favor weight loss in breastfeeding women, loss by 12 months' postpartum is on average less than the amount needed to return to prepregnancy weight.[122] A 2015 study reported that nearly a third of women who were of normal body weight prior to pregnancy were overweight or obese at a year postpartum. Postpartum weight management programs for breastfeeding women that include an energy-restricted diet appear to be the most effective approach to promoting weight loss.[123]

A number of small studies in the United States have addressed the issue of whether weight loss influences milk production. Strode et al.[124] first observed women who voluntarily reduced their energy intake to 68 percent of their estimated needs for 7 days. No differences in infant intake or milk composition were observed. In the week following the diet, women who consumed fewer than 1,500 kcal tended to experience a decrease in milk volume.[125] Women who consumed over 1,500 kcal per day experienced no decrease. The 2020 Dietary Guidelines for Lactation recommend a minimum of 1,800 calories per day to achieve adequate nutrients.[116] In addition, 22 healthy postpartum women who participated in a 10-week weight-loss program that reduced energy intake by 23 percent maintained milk production.[126] The women lost an average of about a pound a week during the 10 weeks.

Studies of weight loss during lactation also suggest that modest energy restriction (500 kcal per day) can be accomplished without large decreases in the quality of the maternal diet, but that the macronutrient content of the diet may influence maternal weight loss and fat content of the milk differentially. Maternal reduction of energy intake through lowered intake of sugary and high-fat foods resulted in similar micronutrient intakes to women who did not decrease intake, with the exceptions of calcium and vitamin D.[127] None of the women consumed adequate vitamins C or E. Therefore, careful attention to consumption of (1) calcium- and vitamin D–rich foods such as low-fat and fat-free dairy products, and (2) fruits, vegetables, and whole grains is needed. A small recent study challenges conventional wisdom that suggests that diet does not substantively alter human milk composition. When the women consumed a high-fat diet (55 percent fat, 30 percent carbohydrate, 15 percent protein), they had similar milk volume and similar protein and carbohydrate content of milk, but a greater energy deficit through higher milk-fat content milk than when they consumed a high-carbohydrate diet (60 percent carbohydrate, 15 percent protein, 25 percent fat).[127]

Exercise and Breastfeeding

Studies[128] examining the effect of increasing energy expenditure on weight and lactation suggest that it is safe in moderation, but does not promote weight loss as compared to diet or a combination of diet and exercise.[3,124] The available evidence suggests that modest energy restriction combined with increases in activity may be effective at helping women to lose weight, while improving their metabolic profile and increasing fat losses.

Vitamin and Mineral Supplements

A 1991 Institute of Medicine report, *Nutrition During Lactation*, stated that well-nourished breastfeeding women do not need routine vitamin or mineral supplementat[95] Instead, supplementation should target specific nutritional needs of individual women. This report continues to be supported by current research and recommendations. Supplementation strategies should take into account how nutrients are secreted into human milk and the potential for nutrient–nutrient interactions in mothers and their infants. For example, women who avoid dairy products completely should use calcium (1,200 mg) and vitamin D (10 µg) supplements. Women who are deficient in vitamin D should take vitamin D supplementation following the recommendations of their physician.[113]

Vitamin and Mineral Intakes

Vitamin and mineral intakes that do not meet recommended levels (of folate, thiamin, vitamin A, calcium, iron, and zinc) have been reported for lactating women.[42,113,115] However, these reports of inadequate intake have not often been followed by reports of deficits in nutritional status of the mother–infant pair. Nor is there a recommendation for vitamin and mineral supplements for all breastfeeding women. A careful balance is needed between concern over inadequate maternal dietary intake and causing women not to breastfeed because they do not have an optimal diet.

Functional Foods

Concern has been expressed about possible ill effects of high intakes of fortified foods in addition to supplements. Although this is an important issue, studies to date have not identified adverse reactions related to fortified-food consumption and RDA levels of nutrients in supplements.

Fluids

There is no evidence that increasing fluid intake will increase milk production or that a short-term fluid deficit results in a decrease in milk production. Fluid demands rise during breastfeeding, however, so women should drink fluids to thirst. Once a mother and her infant have the nursing routine down, she may find it convenient to have something to drink while she nurses. Although many women want to know how many glasses to drink per day, the amount needed varies depending on climate, milk production, body

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size, and other factors. Drinking excessive fluids can have a negative impact on supply.[3] Therefore, women are advised to drink enough fluids to keep their urine pale yellow. The current RDI for water for lactating women is 3.8 L.[129]

Vegetarian Diets

A vegetarian dietary pattern can be chosen by breastfeeding women without compromise to their nutritional status or their infant. The goal is to adequately nourish the mother and child, not to force women to use supplements and/or products that are not part of their normal eating patterns. Incorporation of soy products, vegetarian diets of various sorts, and other alternative diet choices can be followed as long as they meet maternal nutritional needs. Vegans who do not consume dairy products and eggs, however, may need to plan carefully to consume adequate amounts of calories, protein, calcium, vitamins D and B_{12}, iron, and zinc. Vegetarians' intakes of protein are generally adequate as long as energy intake is adequate. Breastfeeding women who consume no animal products should use plant foods with bioavailable B_{12} from sources such as yeasts, seaweed, and fortified soy products. Women who are unable to get adequate B_{12} from foods should take a vitamin B_{12} supplement because human milk may be low in vitamin B_{12} even when mothers do not exhibit deficiency symptoms. Refer to Chapter 7 for information on the use of herbals during breastfeeding.

Infant Colic

Infant colic is defined as crying for more than three hours a day, more than three days per week, for longer than 3 weeks when the cause is not a medical problem. Colic typically peaks at 6 weeks of age and resolves by 3 to 6 months of age.[130] The cause of colic is unknown, however, it is widely believed that components of maternal diet are related to infant colic. Information is growing to support this idea.[130,131] An observational trial suggested that a mother's consumption of cow's milk, onions, cabbage, broccoli, and chocolate were associated with greater likelihood of colic in the infant.[130] A randomized trial assessing maternal avoidance of cow's milk, eggs, peanuts, tree nuts, wheat, soy, and fish resulted in a reduction in colic symptoms of their infants in the first 6 weeks of life.[131] Other studies suggest a different mechanism causing colic unrelated to diet. A marker of colonic inflammation calprotectin has been identified in higher levels in infants with colic.[132] Women should be encouraged to keep a food record detailing food exclusions and colic symptom changes and only exclude those foods that seem to cause problems. If food groups are excluded, women should be careful to replace nutrients that might be lost by avoiding classes of foods. For example, excluding dairy foods may limit calcium and vitamin D intake.

Probiotics seem to be safe and useful in reducing symptoms of infant colic. Initial findings included different microbiota in infants with colic.[133] A meta-analysis concluded that infants receiving *Lactobacillus reuteri* were twice as likely to a 50 percent reduction in crying.[134]

6.8 Public Food and Nutrition Programs

In 1989, Congress mandated (Public Law 101–147) a specific portion of each state's Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) budget allocation to be used exclusively for the promotion and support of breastfeeding. This law authorized the use of WIC administrative funds to purchase breastfeeding aids such as breast pumps. Through this legislation, each state has a breastfeeding coordinator and a plan to coordinate operations with local agency programs for breastfeeding promotion.

The USDA Food and Nutrition Information Center supports a WIC Works website (https://lovingsupport.nal.usda.gov/wic-staff) to serve health and nutrition professionals working in the WIC program. The website includes links to training materials on breastfeeding promotion and information on how to share resources and recommendations. The USDA has a website supporting WIC Breastfeeding (https://wicbreastfeeding.fns.usda.gov/). This website consists of several educational videos, stages of breastfeeding, and information to support challenges and questions lactating women and persons face during their breastfeeding experience. In participating states, the Farmers Market Nutrition Program provides checks to WIC participants so that they can purchase locally grown fruits and vegetables (www.health.ny.gov/prevention /nutrition/fmnp/).

6.9 Optimal Duration, Influential Factors, and U.S. Goals for Breastfeeding

> "During the twentieth century, infant feeding practices have undergone dramatic changes that reflect shifts in values and attitudes in the U.S. society as a whole. They have tended to occur first among those women at the forefront of changes in dominant social values and among those with resources (whether it is time, energy or money) to permit adoption of new feeding practices."
>
> —Institute of Medicine, Subcommittee on Nutrition During Lactation, 1991[95]

Optimal Breastfeeding Duration

The health of a mother–child pair should be the primary criteria to determine the optimal duration of breastfeeding—and not simply whether the cultural environment makes

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Table 6.8 Healthy People 2030 objectives on breastfeeding

Maternal Child Health Objective	Baseline (Year Measured) %	2030 Target %
Increase the proportion of infants who are breastfed exclusive through age 6 months (MICH-15)	(2015 births) 24.9%	42.4%
Increase the proportion of infants who are breastfed at 1 year (MICH-16)	(2015 births) 35.9%	54.1%

Source: Healthy People—Healthy People 2030. Available at http:/health.gov/healthypeople/search?query=maternal+child.

such duration practical. The consensus among expert groups[71,82] is human milk feeding exclusively for approximately 6 months with continued breastfeeding for a year or longer as mom and baby desire. Infants who are breastfed for 6 months experience fewer illnesses from gastrointestinal infection than do infants who are given HMS and breast milk at 3 or 4 months of age. Deficits in growth have not been demonstrated among infants in developing or developed countries who are exclusively breastfed for 6 months or longer. Breastfeeding can prevent intestinal blood loss in infants—a factor that should be considered when determining its optimal duration. Infants fed cow's milk before the age of 6 months suffer nutritionally significant losses of iron via intestinal blood. Through 1 year, breastfed infants suffer fewer acute infections than formula-fed infants do, a finding that supports breastfeeding beyond the introduction of solids.

Breastfeeding Goals for the United States

Healthy People 2030 has a vision of "Improving health and well-being nationwide."[135] The 2030 breastfeeding objectives continue to focus on increasing both the proportion of infants exclusively breastfed through 6 months as well as the duration of breastfeeding at 1 year (Table 6.8).[136,137]

The Surgeon General's Call to Action to Support Breastfeeding

The 2011 Surgeon General's Call to Action to Support Breastfeeding recognizes the levels of support needed for increasing breastfeeding (Figure 6.7) and the key barriers to breastfeeding (Figure 6.8). Twenty specific actions to increase support for breastfeeding are identified. These actions recognize that support is needed at the individual and family level, by communities, healthcare providers, employers, through research and surveillance, and in public health infrastructure. Key barriers are organized into seven domains: (1) lack of knowledge; (2) social norms; (3) poor family and social support; (4) lactation problems; (5) embarrassment; (6) employment and child care; and (7) barriers related to health services.

Breastfeeding Rates in the United States

Breastfeeding duration has changed markedly over the last century. In the early 1900s, almost all infants in the United States were breastfed. As safe HMS became widely available, breastfeeding rates steadily declined, reaching levels below 30 percent in the 1950s and 1960s, and then rose dramatically in the 1970s. In the early 1980s, levels peaked above 60 percent, declined until the early 1990s, and then began rising again through the 2000s. The 2022 Centers for Disease Control and Prevention (CDC) Breastfeeding Report Card suggests that breastfeeding rates for infants who have ever breastfed and infants who are breastfeeding at 6 months remained stable. Exclusive breastfeeding rates increased slightly. The percentage of infants who received

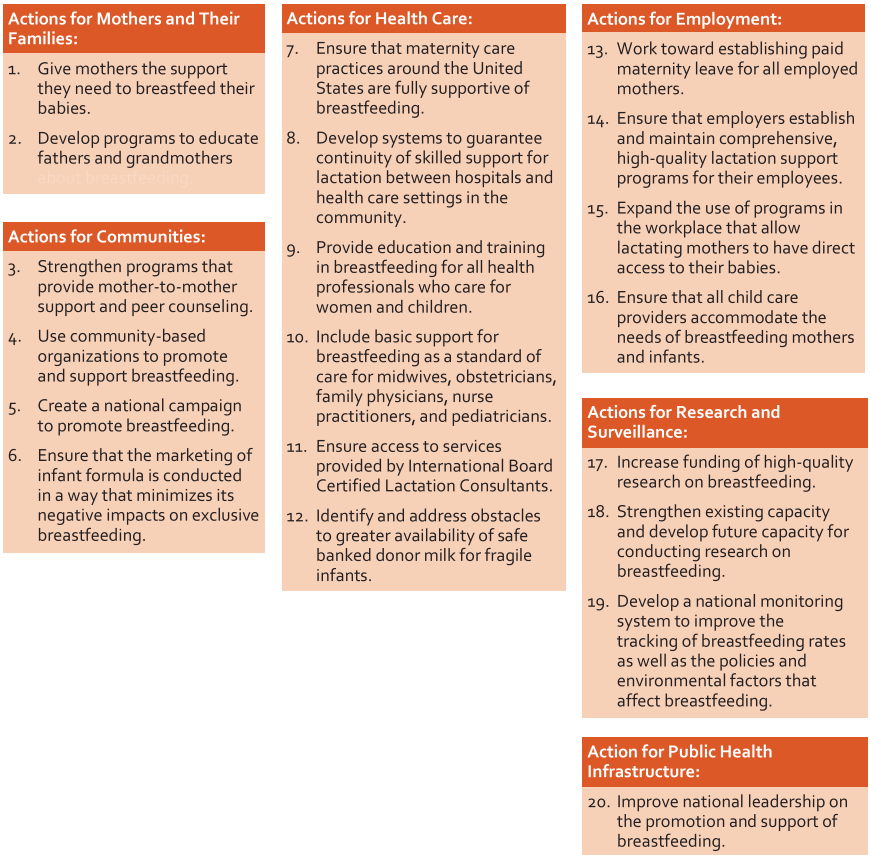


Figure 6.7 Levels of support needed for increasing breastfeeding.

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Lack of Knowledge

While breastfeeding is considered a natural skill, some mothers may need education and guidance. Providing accurate information can help prepare mothers for breastfeeding.

Lactation Problems

Without good support, many women have problems with breastfeeding. Most of these are avoidable if identified and treated early, and need not pose a threat to continued breastfeeding.

Poor Family and Social Support

Fathers, grandmothers, and other family members strongly influence mothers' decisions about starting, continuing, and accommodating breastfeeding.

Social Norms

Many people see breastfeeding as an alternative rather the routine way to feed infants.

Embarrassment

The popular culture's sexualization of breasts compels some women to conceal breastfeeding. Improving support for women to breastfeed can help them better accommodate the demands of everyday life while protecting their infants' health.

Employment and Child Care

Employed mothers typically find that (1) returning to work and (2) lack of maternity leave are significant barriers to breastfeeding.

Health Services

Health care systems and health care providers can improve mothers' breastfeeding experiences by pursuing and obtaining the training and education opportunities they need in order to fully support their patients.

Figure 6.8 Key barriers to breastfeeding.

formula before 2 days of life increased in the 2020 Breastfeeding Report Card and remained the same percentage in the 2022 Breastfeeding Report Card compared to the 2018 Breastfeeding Report Card.[2,136]

Gaps in breastfeeding remain—geographically, among racial groups, by age, educational groups, marital status, and income level[137] (Table 6.9). The lowest initiation rates are in West Virginia and Mississippi, where they remain at or below 70 percent. According to the CDC Breastfeeding Report Card 2020, no states are meeting the Healthy People 2030 goal of 42.4 percent exclusive breastfeeding at 6 months. Minnesota has the highest rate of exclusive breastfeeding at 6 months with a rate of 36.5 percent. Hawai'i and Vermont are the only states in the CDC Breastfeeding Report Card that are meeting the Healthy People 2030 goal of 54 percent of infants breastfeeding at 12 months of age.[2] Breastfeeding varies substantially by racial groups with the lowest rates of breastfeeding among Black or African American women. Breastfeeding initiation and duration increases\ with the age and education of the mother. Married women breastfeed more often than unmarried women and breastfeeding rates rise with income level.[137]

The CDC monitors maternity care practices and policies related to breastfeeding that impact newborn feeding,

Table 6.9 Rates of any and exclusive breastfeeding among children born in 2019

Characteristic	Ever Breastfeeding % (± half 95% CI)[1]	Breastfed Exclusively Through 6 months % (± half 95% CI)[2]	Breastfed at 12 Months % (± half 95% CI)
Total*	83.2 ± 1.0	24.9 ± 1.1	35.9 ± 1.2
White, non-Hispanic	85.3 ± 1.3	26.9 ± 1.5	39.4 ± 1.6
Black, non-Hispanic	74.1 ± 3.7	19.1 ± 2.8	24.1 ± 2.8
Hispanic	83.0 ± 2.3	23.5 ± 2.5	33.2 ± 2.7
Poverty Income Ratio††			
<100	74.0 ± 2.7	19.3 ± 2.3	24.9 ± 2.4
100–199	80.1 ± 2.4	22.3 ± 2.5	31.5 ± 2.8
200–399	85.3 ± 1.9	28.5 ± 2.3	39.1 ± 2.4
400–599	90.7 ± 2.1	28.3 ± 2.6	46.4 ± 3.0
≥600	91.6 ± 1.5	29.0 ± 2.5	44.3 ± 2.8

[1]Breastfeeding rates are based on landline and cellular telephone samples from the 2016 and 2017 National Immunization Surveys.

[2]Exclusive breastfeeding is defined as only breastmilk, no solids, no water, and no other liquids.

*All racial/ethnic groups are included in the total in all other demographic breakdowns, but only the largest groups are presented here.

††Ratio of self-reported family income to the federal threshold value depending on the number of people in the household.

Source: Adapted from: Centers for Disease Control and Prevention. Rates of Any and Exclusive Breastfeeding Rates by Sociodemographics—2019 Birth, CDC—National Immunization Survey. Atlanta, GA. Available at https://www.cdc.gov/breastfeeding/data/nis_data/datea-files/2019, accessed May 27, 2023.

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feeding education, staff skills and discharge support in hospitals and birthing centers with the Maternity Practices in Infant Nutrition and Care (mPINC) survey (www.cdc.gov/breastfeeding /data/mpinc/pdf/mPINC-national-report-h.pdf). This survey monitors supportive practices (Table 6.10). Data are reported at the national, state, and individual facility data showing strengths and areas needing improvement at each level. Still, many hospitals routinely feed formula to healthy, breastfeeding infants when there was no medical reason to do so. For example, the number of births in hospitals providing ideal responses to the question regarding breastfed newborns receiving infant formula was 38 percent in 2020, down from 39 percent in 2018. The survey was redesigned in 2018 and cannot be compared to earlier results.[138]

Table 6.10 Supportive hospital practices

Supportive Hospital Practices
Birth facility policies and practices that create a supportive environment for breastfeeding begin prenatally and continue through discharge, and include:
• **Skin-to-skin contact**—Doctors and midwives place newborns skin-to-skin with their mothers immediately after birth, with no bedding or clothing between them, allowing enough uninterrupted time (at least 30 minutes) for mother and baby to start breastfeeding well.
• **Teaching about breastfeeding**—Hospital staff teach mothers and babies how to breastfeed and to recognize and respond to important feeding cues.
• **Early and frequent breastfeeding**—Hospital staff help mothers and babies start breastfeeding as soon as possible after birth, with many opportunities to practice throughout the hospital stay. Pacifiers are saved for medical procedures.
• **Exclusive breastfeeding**—Hospital staff only disrupt breastfeeding with supplementary feedings in cases of rare medical complications.
• **Rooming-in**—Hospital staff encourage mothers and babies to room together and teach families the benefits of this kind of close contact, including better quality and quantity of sleep for both and more opportunities to practice breastfeeding.
• **Active follow-up after discharge**—Hospital staff schedule in-person breastfeeding follow-up visits for mothers and babies after they go home to check up on breastfeeding, help resolve any feeding problems, and connect families to community breastfeeding resources.

Source: Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion, www.cdc.gov/breastfeeding/data/mpinc/maternity-care-practices.htm.

doula An individual who surrounds, interacts with, and aids the mother at any time within the period that includes pregnancy, birth, and lactation; may be a relative, friend, or neighbor and is usually but not necessarily female. One who gives psychological encouragement and physical assistance to a new mother.[5]

6.10 Breastfeeding Promotion, Facilitation, and Support

"Significant steps must be taken to increase breastfeeding rates in the United States and to close the wide racial and ethnic gaps in breastfeeding. This goal can only be achieved by supporting breastfeeding in the family, community, workplace, health-care sector, and society."

—Health and Human Services Blueprint for Action on Breastfeeding, 2000[138]

Prenatal Breastfeeding Education and Support

Culturally competent prenatal breastfeeding education that is given frequently in person can have a significant positive influence on breastfeeding rates.[139,140] Early in pregnancy, women need information on what to expect in the hospital or birthing center and practical tips for initiating breastfeeding (Table 6.11).[141] Because partners, fathers,[142] grandmothers, **doulas**, friends, and social networks[140] all have a powerful influence on infant feeding decisions, it is important to include these key people as often as possible in breastfeeding promotion efforts. Several key points are shown in Table 6.12.[135,138,143]

Table 6.11 The Best Start three-step breastfeeding counseling strategy[141]

1. Ask open-ended questions to identify the woman's concerns. • Dietitian: "What have you heard about breastfeeding?" • Client: "I hear it's best for my baby, but all my friends say it really hurts!"
2. Affirm her feelings by reassuring her that these feelings are normal. • Dietitian: "You know, most women worry about whether it will hurt."
3. Educate by clarifying how other women like her have dealt with her concerns. Avoid overeducating or giving the impression that breastfeeding is hard to master. • Dietitian: "Did you know that it is not supposed to be painful, and if you are having discomfort, there are people who can help make it better?"

Table 6.12 Key teaching points prior to birth

In the hospital or birthing center, mothers should:
Request early first feeding and skin-to-skin contact
Practice frequent, exclusive breastfeeding
Ask to be taught swallowing indicators
Learn indicators of sufficient intake
Ask for help if it hurts
Know sources for help
Understand postpartum rest and recovery needs
Avoid supplements unless medically indicated

Source: Adapted from S. Page-Goertz and S. McCamman, Breastfeeding success: You can make the difference. *The Perinatal Nutrition Report,* 4 (Winter 1998).[143]

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Breastfeeding Support for Individuals

Peer counselors and peer group discussions with at least one or two women who have successfully breastfed is a successful way to promote breastfeeding.[144,145] Exposure to mothers nursing their babies increases a woman's level of comfort with breastfeeding and provides a forum for informal discussion with family and friends. Social media is an important vehicle for breastfeeding information that has not yet been utilized to its full potential.[146] Discussion of an individual's personal experience can be an effective way to help women see and believe that others like her share her concerns.

All new mothers need support for breastfeeding. However, low-income women often lack the support, knowledge, and confidence to interpret the abundant and pervasive mixed messages on infant feeding practices.[147] Consider the strikingly different context for pregnancy, birth, and parenting for low-income women and their more affluent counterparts.

Profile of a Pregnant Woman Who Receives Temporary Assistance for Needy Families (TANF) She says she wants to do what is best for her baby and, in fact, knows the breast is best. However, she is worried about breastfeeding because her family members and friends have not breastfed. She feels uncomfortable nursing around family, her employer, and co-workers, much less in public. To make things more difficult, in the hospital, she is separated from her baby soon after delivery and is given little assistance for getting started. She struggles with breastfeeding her baby in the hospital and is not comfortable asking the nurse for help and is sent home from the hospital with free samples of formula. At home she has a supportive partner, however, since her family members and friends have not breastfed their children, they are not able to provide her with help after discharge and are unaware of lactation resources in the community. She enrolls in the Special Supplemental Nutrition Program for Women, Infants, and Children and at her first appointment tells the dietitian she has been using the formula that was sent home from the hospital and is planning to bottle feed her baby.

Profile of a Pregnant Woman Who Is in the Highest Socioeconomic Status The affluent expectant mother also wants to do what is best for her baby. However, she has friends who have breastfed and have helped build her confidence that she can breastfeed successfully. She may have been able to choose her birth setting and select a hospital with knowledgeable staff who allow mother and baby to stay together around the clock. Because she knows there may be bumps in the road getting started, she seeks out support from friends, a lactation consultant, or the doctor after discharge. At home, she has a supportive partner who is proud of her for offering the best for their baby. When she returns to work, she knows she can still pump during the day and breastfeed at night to keep that special closeness with her baby even after returning to work.[148–150]

Innocenti Declaration On the Protection, Promotion, and Support of Breastfeeding: Policy statement adopted by participants at the WHO/UNICEF policymakers' meeting on breastfeeding, a global initiative held in Italy in 1990. The policy established exclusive breastfeeding from birth to 4–6 months of age as a global goal for optimal maternal and child health.

Role of the Health-Care System in Supporting Breastfeeding

In 2002, the WHO and UNICEF came together to try to revitalize the international community in breastfeeding promotion with the Global Strategy for Infant and Young Child Feeding.[80] This report builds on the **Innocenti Declaration** and the Baby Friendly Hospital Initiative by recognizing the importance of breastfeeding in all children, including those in difficult circumstances such as emergency situations, low-birth-weight infants, and infants of mothers with HIV. The initiative includes the following:

- A call on governments to develop and implement policy on infant and child feeding within the context of the national policy for nutrition, child, and reproductive health as well as poverty reduction
- Access to skilled support for initiation and maintenance of breastfeeding exclusively for 6 months and with safe complementary foods for up to 2 years or beyond
- Empowerment of health-care professionals to provide breastfeeding support and extend their services into the community
- Review of progress in implementation of the International Code of Marketing of Breast Milk Substitutes (Table 6.13)[151] and consideration of

Table 6.13 WHO's international/UNICEF code on the marketing of breast milk substitutes

• No advertising of breast milk substitutes
• No free samples or supplies
• No promotion of products through health-care facilities
• No company sales representative to advise mothers
• No gifts or personal samples to health workers
• No gifts or pictures idealizing formula feeding, including pictures of infants, on the labels of the infant milk containers
• Information to health workers should be scientific and factual
• All information on artificial feeding, including labels, should explain the benefits of breastfeeding and the costs and hazards associated with formula feeding
• Unsuitable products should not be promoted for babies
• Manufacturers and distributors should comply with the Code's provisions even if countries have not adopted laws or other measures

Source: Adapted from World Health Organization International Code of Marketing of Breast-milk Substitutes. Geneva, Switzerland, 1981.[151]

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new measures to protect families from commercial interests and influence
- Enactment of legislation to protect the breastfeeding rights of working women in accordance with international labor standards

This report provides an important framework for acceleration of support of appropriate feeding for infants and children worldwide by linking resources and intervention areas available in many sectors.

Health-care providers and facilities exert tremendous influence over the mother–infant dyad, with the power to promote and model optimal breastfeeding practices during prenatal care, at delivery, and after discharge. The importance of the health-care system in breastfeeding success is evident by the inclusion of process indicators for breastfeeding in the Healthy People 2030 objectives and the mPINC Surveys.[136,137]

Lactation Support in Hospitals and Birthing Centers

Hospital policies and routines significantly affect critical early experience with breastfeeding, with effects extending far beyond the short stay.[149,152] Table 6.14 provides examples of practices that influence this pivotal initiation experience. As in prenatal care settings, the distribution of infant formula coupons and free samples of formula in hospital discharge packs is discouraged because of the detrimental effects of this practice on breastfeeding success, particularly among vulnerable groups such as new mothers and low-income women. Model policies for hospitals and physicians are available from the U.S. Breastfeeding Committee (www.usbreastfeeding.org) and the Academy of Breastfeeding Medicine (www.bfmed.org).

In an effort to promote, protect, and support breastfeeding in hospitals and birthing centers worldwide, the WHO and UNICEF established the Baby-Friendly Hospital Initiative (BFHI) in 1993 (www.babyfriendlyusa.org).[153] This initiative focuses on 10 evidence-based components of hospital care that impact on breastfeeding success (Table 6.12). The Baby-Friendly Hospital Initiative is responsible for an increase in breastfeeding rates. The Baby-Friendly USA program that designates facilities within the United States who meet the guidelines likely contributed to the rapid increase in number of infants in the United States born in hospitals providing recommended breastfeeding care.[153] Exposure to baby-friendly hospital practices by participants significantly increased their likelihood to meet breastfeeding duration goals. One study showed exposure to exclusive breastfeeding and health-care providers sharing breastfeeding support education were associated with breastfeeding intentions being met compared to participants who did not receive exposure to baby-friendly hospital practices.

Successful maternal education program examples are highlighted in *The CDC Guide to Breastfeeding Interventions*.[145] These include health insurance plans that provide breastfeeding education for their members, BFHI programs offering patients infant-feeding classes, and health departments offering training programs for persons who provide breastfeeding education.

Model U.S. Baby-Friendly Hospital Programs

Across the United States, several states have taken BFHI and developed programs to increase breastfeeding initiation rates and breastfeeding duration. One of the first of its kind, the Best Feedings Beginnings program, a national quality improvement program was established to increase the number of hospitals receiving baby friendly hospital designation by improving maternity care processes. Eighty-nine hospital teams from 29 states participated in the Best Feeds Beginnings program from 2011–2015 (htpps://www.nichq.org/impact/our-work).

Kaiser Permanente has made a commitment to the Partnership for a Healthier America (PHA) to have all maternity facilities in their system implement the Baby-Friendly Hospital Ten Steps.[154] The number of BFHI-designated hospitals in the United States increased from 20 in 2008 to 56 in 2012 to over 600 in 2019, BFHI-designated hospitals are now found in Puerto Rico, the District of Columbia and all 50 states. There are now over 20,000 maternity facilities in 150 countries around the world who have achieved the baby friendly designation (www.babyfriendlyusa.org/about/). The numbers of BHFI designated facilities in the United States and across the world continue to increase providing mothers with the highest standards of breastfeeding knowledge and support.

The State of California has also been working to increase breastfeeding rates by implementing other programs. The Paid Family Leave program is an insurance program that replaces income for workers who take time to care for a child. Women who participated in this program had double the breastfeeding duration when compared to women who did not participate. Increasing awareness of this program is a current state-wide effort.

New York conducted a state-wide survey of 138 hospitals assessing how hospitals were doing, with meeting the Ten Steps was also part of the survey. Over half of the hospitals surveyed reported having interest in implementing Baby-Friendly Hospital protocols. Exclusive breastfeeding was more likely when a hospital supported immediate breastfeeding initiation.

Jennie Joseph, a midwife and owner of The Birth Place in Winter Garden was one of 12 named to Time's Women of the year list in 2022. Jennie was chosen because of her efforts and advocacy for women and babies to have equality and equity in health-care. Jennie reported in her interview that pregnant mothers and families who can not pay are supported in her clinic. She also operates a midwifery training school and was nationally recognized in 2020 as the first Black person to do so. Her work and recognitions have brough more awareness to the importance of her work enabling her to help more people and reduce racial

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Table 6.14 Ten steps to successful breastfeeding

Percentage of hospitals with ideal practice on indicators of the 10 Steps to Successful Breastfeeding			
10 Steps to Successful Breastfeeding Criteria	**M PINC indicator**	**2018**	**2020**
		% of 2103 Hospitals	**% of 2103 Hospitals**
Have a written breastfeeding policy that is routinely communicated to all health-care staff.	Model breastfeeding policy: Hospital has 100% of written policy elements	29%	33%
Train all health-care staff in the skills necessary to implement this policy.	Staff competency assessment: Nurses are required to demonstrate competency in assessing breastfeeding (milk transfer and maternal pain), assisting with breastfeeding (position and latch), teaching hand expression and safe formula preparation/feeding, and demonstrating safe skin to skin practices.	61%	68%
Inform all pregnant women about the benefits and management of breastfeeding.	Prenatal breastfeeding education: When breastfeeding mothers request infant formula, staff counsel them about possible consequences.	60%	61%
Help mothers initiate breastfeeding within half 1 hour of birth.	Early initiation of breastfeeding: Newborns remain in interrupted skin-to-skin contact for at least 1 hour or until breastfeed (vaginal/cesarean delivery).	67%/50%	71%/52%
Show mothers how to breastfeed and how to maintain lactation, even if they are separated from their infants.	Teach breastfeeding techniques: Breastfeeding mothers are taught/shown how to position and latch their newborn, assess effective breastfeeding, and hand expression.	66%	70%
Give infants no food or drink other than breast milk, unless medically indicated.	Limited non–breast milk feeds of breastfed infants: Few breastfeeding newborns receive infant formula	39%	38%
Practice rooming-in, allow mothers and infants to remain together 24 hours a day.	Rooming-in: Mother-infant dyads are rooming-in 24 hours/day.	73%	81%
Encourage breastfeeding on demand.	Teach feeding cues: Breastfeeding mothers are taught/shown how to recognize/respond to feeding cues, to breastfeed on-demand, and to understand the risks of artificial nipples/pacifiers.	73%	75%
Give no artificial pacifiers or artificial nipples to breastfeeding infants.	Limited use of pacifiers: Hospital does NOT give mothers any of these items as gifts or free samples: infant formula, feeding bottles/nipples, nipple shields, or pacifiers; coupons, discounts, or educational materials from companies that make/sell infant formula/feeding products.	64%	67%
Foster the establishment of breastfeeding support groups and refer mothers to them on discharge from the hospital or birth center.	Post-discharge support: Hospital's discharge support to breastfeeding mothers includes in-person follow-up visits/appointments, personalized phone calls, or formalized, coordinated referrals to lactation providers.	91%	91%

Sources: Centers for Disease Control and Prevention. 2020 National Results Report, CDC Survey of Maternity Care Practices in Infant Nutrition and Care. Atlanta, GA. September 2021; and 2020 National Results Report (cdc.gov).

and socio-economic disparities in maternal health-care (https://time.com/women-of-the-year).

The environment for the delivery of prenatal care is an important barrier or facilitator of breastfeeding. It should provide positive messages about breastfeeding, such as posters that promote breastfeeding and magazines and literature in the waiting room; there should be no advertisements or promotions of formula. Patient education materials that include formula advertising, samples, and business reply cards for free formula[155] are in direct violation of the WHO's International Code on the Marketing of Breast Milk Substitutes (Table 6.13).[156] Women who have been exposed to materials and products from formula companies prenatally are more likely to stop breastfeeding in the first 2 weeks. Use of these materials provides a subtle message that infant formula is equivalent to breast milk.

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Evidence stemming from focus groups intended to inform a national campaign to promote breastfeeding in the United States suggests that breastfeeding is a learned skill.[157] The process associated with success is called *confident commitment*. The components are (1) confidence in the process of breastfeeding, (2) confidence in the ability to breastfeed, and (3) commitment to making breastfeeding work despite obstacles. Mothers who achieved confident commitment before birth were successful when faced with common challenges of breastfeeding. In contrast, among mothers without "confident commitment," the decision to breastfeed weakened with challenges.

Although not all women or birthing persons will choose to breastfeed, the goal of prenatal breastfeeding education is to empower every woman or birthing person with sufficient knowledge to make an informed decision about how to feed her baby. Some professionals view breastfeeding as a personal choice rather than a public health issue and voice concern that breastfeeding promotional efforts may cause women who choose HMS feeding to feel guilty. On the other hand, some women who formula-feed report feeling angry about not getting enough breastfeeding information during their pregnancy.[138] In recognition of the benefits of breastfeeding and the important role of health professionals in promoting and supporting breastfeeding, the leading health and professional organizations in the United States that provide perinatal care have established policies in support of breastfeeding as the preferred infant feeding method.[115,135]

Lactation Support after Discharge

Breastfeeding support is essential in the first few weeks after delivery, as lactation is being established[158] (Table 6.15). Younger women and women with lower socioeconomic status are more likely to stop breastfeeding by four weeks postpartum and cite sore nipples, inadequate milk supply, feeling that the infant is not satisfied, and infant problems as reasons for stopping.[146,159]

A pediatrician, nurse, or other knowledgeable health-care practitioner should see all breastfeeding mothers and their newborns, either on a home visit or in the office, when the newborn is 2–4 days of age. Breastfeeding should be observed and evaluated for evidence of successful breastfeeding behavior. This is also an important time to revisit the major concerns the mother identified during pregnancy, as well as discuss any new concerns. Mothers should be armed with information on sources of trained, skilled, and available help in the community, such as **lactation consultants**, peer counselors, the WIC program, or **La Leche League**, should questions or complications arise.[144] Follow-up telephone calls, as necessary, provide additional support to mothers who are not fully confident in their ability to breastfeed successfully.

Table 6.15 Lactation support from diverse organizations

Latinx/Hispanic Organizations
https://www.usbreastfeeding.org/hispanic-heritage-month.html
African/American Black Organizations:
https://breastfeedingrose.org/
https://www.cinnamoms.org/ (A breastfeeding program within WIC)
https://blackmothersbreastfeeding.org/
Asian Pacific Islander Breastfeeding Taskforce
https://www.breastfeedla.org/aapi-breastfeeding-task-force/
https://breastfeeddurham.org/equity/asian-pacific-islander-breastfeeding-resources-library/

The Workplace

One of the important barriers to breastfeeding includes lack of on-site day care, insufficiently paid maternity leave, rigid work schedules, and employers who lack knowledge about breastfeeding. Current law ensures a woman's right to breastfeed her infant anywhere on federal property that she and her child are authorized to be.

Breastfeeding duration is adversely affected by employment.[148,150] Return to work before 3 months' postpartum is associated with a lower likelihood of meeting ones' breastfeeding intentions.[149] Breastfeeding duration appears to be reduced by longer hours of work and shorter maternity leave. A Los Angeles–area WIC program provided electric pumps upon request to participants and found a 5.5 times greater chance that women did not request formula at 6 months if they received an electric pump when requested than if they did not, suggesting that breastfeeding was more successful after return to work when a breast pump was available.[150] A lactation program (including an employee's choice of a class on the benefits of breastfeeding), services of a lactation consultant, and a private room in the workplace with equipment for pumping resulted in longer duration

Lactation consultant Health-care professional whose scope of practice is focused on providing education and management to prevent and solve breastfeeding problems and to encourage a social environment that effectively supports the breastfeeding mother–infant dyad. Those who successfully complete the International Board of Lactation Consultant Examiners (IBLCE) certification process are entitled to use the IBCLC (International Board Certified Lactation Consultant) after their names (www.iblee.org).

La Leche League International, nonprofit, nonsectarian organization dedicated to providing education, information, support, and encouragement to women who want to breastfeed. Founded in 1956 by seven women who had learned about successful breastfeeding while nursing their own babies, it currently has over 5,000 leaders in over 80 countries on every continent except Antarctica. Accredited lay leaders facilitate mother-to-mothers meetings around the world. These meetings moved online due to the coronavirus pandemic to continue to provide breastfeeding support to mothers. (www.lalecheleague.org).

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even among mothers working full time. These workplace lactation services of having a breast pump for 1 year, telephone support, and return-to-work consultations have been shown to increase exclusive breastfeeding rates in the United States at 6 months dose dependently.[160]

Studies indicate that women who continue to breastfeed once they return to work miss less time from work because of baby-related illnesses and have shorter absences when they do miss work, compared with women who do not breastfeed.[161] Worksite programs that support breastfeeding facilitate the continuation of breastfeeding after mothers return to their jobs and offer additional advantages to employers: employee morale and loyalty, image as family-friendly, recruiting for personnel, and retention of employees after childbirth all improved. National breastfeeding promotion includes Breastfeeding (http://mchb.hrsa.gov/pregnancyandbeyond/breastfeeding/), which provides resources for employers and employees consistent with federal law. Key elements of worksite lactation support programs are presented in Table 6.16.

Women planning to return to work have several choices. There are several tips and resources for women and lactating persons returning to work. One resource previously mentioned resource is the USDA WIC Breastfeeding support website found at https://wicbreastfeeding.fns.usda.gov/talking-your-employer-about-pumping-work. Breast milk can be expressed during the day into sterile containers, refrigerated or frozen, and then used for subsequent bottle feedings when the mother is at work. (Refer to Chapter 7 for storage guidelines.) With on-site child care, it is possible to breastfeed during breaks and lunch hours. Another possibility is to train the body to produce milk only when the mother is home during the evenings and during the night. To accomplish this, a woman should omit one feeding at a time during the periods of the day when she will not be feeding or expressing milk. This will help her reduce her milk supply without experiencing engorgement. She gradually weans to the feedings at the appropriate time of the day. This method works because removal of milk is the stimuli for milk production. Generally, at least two feedings per day are needed for women to continue making milk. Unless a mother is returning to work immediately after delivery, a bottle should not be introduced before lactation is well established, which is usually at least four weeks. Information about hospital-grade breast pumps is readily available on the Internet.

Table 6.16 Important elements of worksite lactation support programs

• Prenatal lactation education tailored for working women
• Corporate policies providing information for all employees on the benefits of breastfeeding and on why their breastfeeding co-workers need support
• Education for personnel about the services available to support breastfeeding women
• Adequate breaks, flexible work hours, job sharing, and part-time work
• Private "Mother's Rooms" for expressing milk in a secure and relaxing environment
• Access to hospital-grade, autocycling breast pumps at the workplace
• Small refrigerators for the safe storage of breast milk
• Subsidization or purchase of individually owned portable breast pumps for employees
• Access to lactation professional on-site or by phone to give breastfeeding education, counseling, and support during pregnancy, after delivery, and when the mother returns to work
• Coordination with on-site or near-site child care programs so the infant can be breastfed during the day
• Support groups for working mothers with children

Source: U.S. Department of Health and Human Services. *HHS Blueprint for Action on Breastfeeding*. Washington, DC: U.S. Department of Health and Human Services, Office on Women's Health, 2000.

The Business Case for Breastfeeding

The Office of Women's Health has created a program called the Business Case for Breastfeeding (www.womenshealth.gov/breastfeeding/employer-solutions/business-case.html) to educate employers about the value of supporting breastfeeding in the workplace. The kit provides a sample policy for supporting breastfeeding employees, a breastfeeding program assessment form, and templates for flyers and feedback, as well as a resource guide so that employers and employees can understand their responsibilities according to federal law.

The Community

To increase breastfeeding rates in a community, it is important to identify community attitudes and obstacles to breastfeeding, and to solicit the support for breastfeeding from community leadership. Establishment of a multidisciplinary breastfeeding task force with representatives from physicians, hospitals and birthing centers, public health, home visitors, La Leche League, government, industry, school boards, and journalists can be an effective vehicle for assessing community breastfeeding support needs and sponsoring collaborative efforts to overcoming community obstacles to breastfeeding.[142] Barriers to breastfeeding may include lack of access to reliable and culturally appropriate sources of information and social support, cultural perception of bottle feeding as the norm, and aggressive marketing of breast milk substitutes. Public outrage in response to a 2006 image of an infant feeding at a woman's breast on the front of a magazine about babies demonstrates that breastfeeding is not perceived as a cultural norm. August 2021 marked the first nationwide Asian American, Native Hawaiian and Pacific Islander (AANHPI) Breastfeeding Week. The theme for this event was "Reclaiming Our Tradition" to support and reclaim breastfeeding as the norm. Unfortunately, infant formula is often believed by many in Asian communities to be a sign of socioeconomic status and superior to breastmilk. According to thousanddays.org, Asian American women were found in a 2016 study to

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introduced foods other than mother's milk to their infants earlier than any other ethnic group. The AANHPI week highlighted AANHPI mothers in videos speaking in their preferred languages "I Breastfeed" to create a sense of village to support new mothers in their breastfeeding journey (thousanddays.org).

Public Health Support of Breastfeeding

In the past decade, legislative efforts at both the federal and state level have been made to protect a woman's right to breastfeed (Table 6.17). States vary widely in not only whether there is legislation relating to breastfeeding, but also the depth and breadth of the legislation (http://www.usbreastfeeding.org). Legislation is used to protect a woman's right to breastfeed, to consider breastfeeding in family law situations, to regulate breast pumps, and to provide incentives to employers who provide breastfeeding support. Legislation addresses issues such as a woman's right to breastfeed in public and on federal property, express milk at work, and be exempt from jury duty. In 2010, Section 4207 of the Patient Protection and Affordable Care Act amended the Fair Labor Standards Act. The amendment requires employers to provide reasonable break time and a private, non-bathroom place for nursing mothers to express breast milk during the workday, for 1 year after the child's birth. In December 2022, The PUMP for Nursing Mothers Act was signed into law. This bill builds on previous right to break laws providing more nursing employees the right to have break times to pump in a private place (http://www.usbreastfeeding.org/workplace-law-guide.html).

Table 6.17 Landmark U.S. breastfeeding policy statements and conferences

• Report of the Surgeon General's Workshop on Breastfeeding and Human Lactation
• Follow-up Report: Surgeon General's Workshop on Breastfeeding and Human Lactation
• Healthy People 2010, 2020, 2030 Breastfeeding Goals for the Nation
• DHHS Maternal and Child Health Bureau National Workshop: Call to Action: Better Nutrition for Mothers, Children, and Families. Washington, DC: National Center for Education in Maternal and Child Health
• Second Follow-up Report: Surgeon General's Workshop on Breastfeeding and Human Lactation
• National Breastfeeding Policy Conference. Presented by the UCLA Center for Healthier Children, Families and Communities, Breastfeeding Resource Program, in cooperation with the U.S. Department of Health and Human Services, Health Resources and Services Administration, Maternal and Child Health Bureau, and the Centers for Disease Control and Prevention
• DHHS Blueprint for Action on Breastfeeding
• U.S. Breastfeeding Committee Strategic Plan
• The Surgeon General's Call to Action to Support Breastfeeding, 2011
• Healthy People 2020 Breastfeeding Goals for the Nation
• Affordable Care Act of 2010

Many HHS agencies have breastfeeding initiatives. The Title V Maternal and Child Health programs of the Health Resources and Services Administration provide substantial support services, training, and research for breastfeeding (http://www.mchb.hrsa.gov). The CDC plays a major role in supporting breastfeeding nationally through applied research, program evaluation, and surveillance (http://www.cdc.gov).

6.11 Model Breastfeeding Promotion Programs

WIC National Breastfeeding Promotion Project—Loving Support Makes Breastfeeding Work

The WIC has always supported breastfeeding, but in 1995 it began to reposition breastfeeding as a way for a family to establish a special relationship with their child from the very onset of his or her life using a social marketing campaign called Best Start.[143] The campaign slogan, "Loving Support Makes Breastfeeding Work," capitalizes on the concept that everyone is important to women's breastfeeding success—family, friends, doctors, and the community. Campaign materials and a counseling program were developed to help mothers work through individual barriers and constraints to breastfeeding. The key messages are (1) helping women feel comfortable with breastfeeding, (2) tips on how breastfeeding can work around a busy schedule, and (3) the involvement of family and friends to make breastfeeding a success. Since 1997, the Loving Support Makes Breastfeeding Work campaign has expanded to 72 state agencies, Indian tribal organizations, and territories participating at various levels.[141]

This program has been implemented at the state level with positive outcomes, including better initiation and duration of breastfeeding. Building on the idea that fathers are important, a father-to-father breastfeeding promotion program in Texas resulted in increased breastfeeding rates at WIC clinics using peer dads.[152] Increased breastfeeding support from relatives and friends was also documented from data collected in a mail survey.

Federal regulations as part of the 2009 appropriations contained provisions to expand the scope of WIC activities to encourage its participants to breastfeed. A national program called Loving Support to Grow and Glow in WIC provided training for local agencies.

WIC peer counselling materials were modified for use by AMEN (Avondale Moms Empowered to Nurse) to launch a peer-to-peer support group to increase breastfeeding rates in a Black urban community where disparities in breastfeeding are seen. Avondale neighborhood mothers were designated Breastfeeding Champions following training and helped increase breastfeeding rates by 12 percent in the neighborhood. These Breastfeeding Champions have now launched

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AMEN support groups in additional Black neighborhoods with the goal to help more mothers reach their breastfeeding goals and reduce racial disparities in breastfeeding.[162]

Texas 10 Steps to Successful Breastfeeding

The Texas Department of State Health Services and Texas Hospital Association created the Texas 10 Steps to Successful Breastfeeding to increase breastfeeding rates and reduce disparities in breastfeeding (http://texastenstep.org/starachiever-texastenstep/ten-steps-to-successful-breastfeedinghtml). This quality improvement program aims to increase exclusive breastfeeding in the immediate postpartum period and sustain exclusive breastfeeding for 6 months.

The Lyndon B. Johnson Hospital in Houston implemented the program and increased the number of women who left the hospital breastfeeding from less than 4 to 33 percent in 1 year (https://www.nichq.org/insight/4-tips-reducing-formula-supplementation-hospital). Supplementation with human milk substitutes was reduced from 73 to 57 percent. Intensive training and education over a year period included sharing the vision, holding the staff accountable, embedding lactation consultants in the labor and delivery Care team, and educating patients. For example, materials for the mothers' support team include advice for how fathers and grandparents can support breastfeeding when the mother and baby go home.

A hospital in Fort Duncan is using the program to address breastfeeding disparities (https://www.nichq.org/insight/closing-breastfeeding-disparity-gap-methods-improvement). This hospital at the Texas-Mexico border serves a nearly 100 percent Hispanic population. Its efforts include getting staff buy-in, committing to in-person bilingual education, understanding the cultural differences, and identifying community champions. Their efforts are being to show a reduction in the number of babies who are supplemented with human milk substitutes. The Texas 10 Steps to Successful Breastfeeding program has been modified and used in other states with permission to increase breastfeeding rates and decrease disparities.

Stanford University Breastfeeding Support Program

Stanford University has developed a program to support breastfeeding goals for students returning to study and employees returning to work. The university has a lactation support website that provides information on lactation resources and lactation spaces on campus (https://cardinalatwork.stanford.edu/benefits-rewards/worklife/children-family/lactation-support). The Stanford Medicine at Lucille Packard Children's Hospital has a website (https://med.stanford.edu/newborns/professional-education/breastfeeding.html) that provides additional lactation support resources, including videos for health-care professionals to use for educational purposes made by Dr. Jane Morton and Global Health Media. These resources have been seen by lactating mothers across the country to promote and support breastfeeding duration goals.

University of California San Francisco Motivating Interdisciplinary Lactation Knowledge (MILK) Research Lab

The MILK Research Lab was set up with the Mission to "Improve maternal health outcomes of Black women and birthing people across the life course." This work is being done through lactation research, and advocacy and policy strategies. The goal is to provide human milk feeding support to Black women and birthing people through breastfeeding/chestfeeding support, resources, and even the use of donor human milk (https://milklab.uscf.edu).

Key Points

1. With rare exceptions, human milk is the optimal food for infants, exclusively for 6 months and with supplemental foods for a year or longer. Benefits to infants include protection from iron deficiency; better gains in cognitive ability; fewer acute respiratory and gastrointestinal illnesses; and lower risk of sudden infant death syndrome, celiac disease, inflammatory bowel disease, neuroblastoma, allergies, and asthma.
2. A thorough understanding of the anatomy and physiology of lactation is key to enabling health-care providers in providing effective lactation support.
3. Maternal benefits of breastfeeding include minimization of postpartum blood loss, delayed fertility, greater self-confidence and bonding with the baby, and reduced risk of ovarian and breast cancers.
4. Newborns who are getting adequate human milk have about six wet diapers and three to four soft, yellowish stools per day by 5–7 days' postpartum. Even slow gainers are alert, bright, and responsive, whereas infants who are failing to thrive are apathetic, hard to arouse, and have a weak cry.
5. Removal of milk from the breast is the stimulus for making more milk. Most women can make enough milk for their infant, although storage capacity (breast size) differences may determine how often the infant feeds in 24 hours.
6. Breastfed infants should be supplemented with vitamin K at birth and with 400 IU of vitamin D per day beginning at 2 months. In areas where water is not fluoridated, infant supplementation after the age of 6 months may be the best choice.

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7. Breastfeeding women can lose modest amounts of weight while breastfeeding by choosing a diet following a healthy dietary pattern. Breastfeeding women need an additional 330 cal per day in the first 6 months, and 400 cal thereafter. Energy intake should be adjusted for activity level and achievement and maintenance of healthy weight.
8. Maternal diet does not significantly alter the protein, carbohydrate, and major mineral composition of breast milk, but it does affect the fatty acid profile, amounts of some vitamins, and some, but not all, trace minerals. For a majority of nutrients, the quality of the milk is preserved over the quantity of milk when maternal diet is inadequate.
9. Maternal diet may be associated with infant colic. Avoidance of cow's milk and cow's-milk products, eggs, peanuts, tree nuts, wheat, soy, and fish have been associated with a reduction in infant colic symptoms in the first 6 weeks of life.
10. Successful breastfeeding is possible for women who follow vegetarian diets. Careful attention to vitamin B_{12} supplementation is important for women who are vegan.
11. Support for breastfeeding/chestfeeding women and lactating persons from husbands and partners, mothers, sisters, health-care providers, communities, employers, and policymakers is critical to breastfeeding success and impacts breastfeeding rates in the community.

Review Questions

1. The composition of human milk changes:
   a. Over the time of day, but stays constant through a single feeding, and over time from birth.
   b. Over the time from birth, but stays constant through a single feeding and over the day.
   c. Over a single feeding, and across the day, but stays constant over time from birth.
   d. Over the time of day, within a single feeding, and over the time since birth.
2. Colostrum differs from mature human milk in the following ways:
   a. It is higher in protein mononuclear cells and is thick and yellow in color.
   b. It is higher in protein, but lower in sodium, potassium, and chloride, and is yellow in color.
   c. It is lower in protein, but higher in fat, sodium, potassium, and chloride, and is bluish in color.
   d. It is lower in protein, higher in carbohydrates, and similar in sodium, potassium, and chloride.
3. The benefits of breastfeeding include:
   a. Hormonal, physical, and psychological benefits for the mother, but no differences for the infant.
   b. No hormonal physical or psychological benefits for the mother, but the infant gets heightened protection from infections and several chronic diseases.
   c. Hormonal, physical, and psychological benefits for the mother, and the infant gets heightened protection from infections and several chronic diseases.
   d. No hormonal benefits, but decreased breast cancer in the mother, and the infant gets heightened protection from infections and several chronic diseases.
4. The best way to increase human milk production is to:
   a. Reduce fat in the mothers' diet.
   b. Remove milk from the breast and feed frequently.
   c. Feed the infant at both breasts in a single feeding.
   d. Use a pump to express milk at the beginning of a feeding.
5. Nipple pain is common in breastfeeding. Women and lactating persons should be counseled to:
   a. Get used to it; it will eventually go away.
   b. Use antibiotic creams to prevent mastitis.
   c. See a lactation consultant for proper positioning of the infant at the breast.
   d. Use a pump instead of having the infant at the breast until the pain goes away.
6. When counseling a healthy woman about what to eat during breastfeeding, the best advice is:
   a. Eat and drink whatever you want; it doesn't change the milk composition or hurt the baby as long as you take a multivitamin.
   b. Eat a variety of foods, following a healthy eating pattern for moms.
   c. Avoid chocolate, mint, tomatoes, onions, and cabbage because they cause colic in the baby.
   d. Avoid wheat, milk, eggs, and nuts to prevent allergies in the infant.

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7. Which of the following is true about maternal weight loss while breastfeeding?
   a. Women should not try to lose weight while breastfeeding because it changes the milk composition.
   b. Women should not try to lose weight while breastfeeding because milk production will suffer.
   c. Women can try to lose weight while breastfeeding as long as it is modest (500 kcal/day deficit).
   d. Women can try to lose as much weight as they want while breastfeeding because ketones in breast milk are not harmful to the baby.
8. A vegan breastfeeding woman should be advised to:
   a. Continue her vegan diet, if she chooses, while making sure that her intake of vitamin B12 and other nutrients is adequate from food and/or supplements.
   b. Continue her vegan diet with no concerns about adequate nutrients in her milk.
   c. Become a lacto-ovo vegetarian to ensure adequate calcium and vitamin D intake.
   d. Begin adding meat and other iron-rich foods to her diet to ensure her milk has adequate iron.
9. Fear of inadequate milk supply is a contributor to early breastfeeding cessation. What would be key components of breastfeeding advice to give to a new mother in the early postpartum period to help her develop confidence in her milk supply?
   a. Buy an infant scale and weigh the infant before and after each feeding.
   b. Feed the infant every 4 hours even if the infant doesn't seem hungry, and if the infant has about six wet diapers a day, she is eating adequately.
   c. Feed the infant when she displays early signs of hunger, and if the infant has about six wet diapers and about three stools daily, she is eating adequately.
   d. Nurse the infant at both breasts at each feeding and offer a formula supplement if the infant still seems hungry.
10. Describe the stages of lactogenesis, including the time frame of breastfeeding, where it occurs, major milk composition changes (if any), and milk production changes.
11. Describe four of the nutritional benefits of human milk to the infant.

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Nutrition During Lactation

Conditions and Interventions

Prepared by Ellen Lechtenberg and Maureen A. Murtaugh

Learning Objectives

After studying the materials in this chapter, you should be able to:

7.1 List at least five common breastfeeding/chestfeeding conditions.

7.2 Associate positive and negative impacts of maternal medications on mother's/lactating persons' breast milk.

7.3 List two examples of herbal galactogogues used during lactation.

7.4 Describe the impact of marijuana on mother's/lactating persons' breast milk.

7.5 Explain causes of hyperbilirubinemia and ways to prevent kernicterus.

7.6 Identify ways health professionals can help the mother of multiples face the challenges of breastfeeding/chestfeeding.

7.7 Distinguish between food allergy and food intolerance.

7.8 Identify at least three factors that contribute to increased readmission rates for late-preterm infants.

7.9 List three benefits of human breast milk for premature infants.

7.10 Demonstrate knowledge of medical contraindications to breastfeeding/chestfeeding.

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7.11 List three guidelines for storage of human milk for home use.

7.12 Analyze one of the model programs for breastfeeding promotion in the United States.

Introduction

The key to successful breastfeeding/chestfeeding management is for the mother or individual providing human milk–infant breastfeeding pair to receive informed, consistent, and individualized support from health-care professionals both in the hospital and after discharge. These culturally sensitive interventions and gender inclusive language increase breastfeeding rates and are critical for positive breastfeeding outcomes.[1] The vast majority of women do not experience significant problems with breastfeeding. Many of the more common problems that do arise can be prevented through prenatal breastfeeding education and a positive, supportive breastfeeding initiation period.

This chapter discusses prevention and treatment of common breastfeeding/chestfeeding conditions. Breastfeeding will be used in this chapter. When working with individuals and families, chestfeeding, lactating persons, or individuals providing human milk may be preferred. Always ask to identify preferred pronouns and terms identified for feeding. Issues related to maternal use of medications, herbal remedies, drugs of abuse, and environmental contaminants are addressed. The chapter presents important considerations for breastfeeding multiples, preterm infants, and infants with medical problems. It provides information on the safe collection and storage of human milk and milk banks. The chapter concludes with case studies providing examples of management of challenging breastfeeding problems and with examples of model programs promoting support for breastfeeding in the health-care system that others should model themselves after.

7.1 Common Breastfeeding Conditions

Sore Nipples

Early, mild nipple discomfort is common among women initiating breastfeeding. Breast pain or nipple pain is experienced by over 90 percent of lactating women during breastfeeding.[2] In most women, the discomfort is transient and usually subsides by the end of the first week. It is, however, not uncommon for some women to experience nipple pain lasting a month postpartum.[3] Severe nipple pain, the presence of nipple cracks or fissures, pain that persists throughout a feeding, or pain that is not improved by the end of the first week should not be considered normal and requires a detailed evaluation.[4] Painful nipples and nipple trauma can lead women to become discouraged and depressed with breastfeeding and lead to early weaning. As many as one third of women who experience nipple pain and trauma switch to bottle feeding within the first 6 to 8 weeks postpartum.[3–5] Nipple pain is the second reason mothers list for discontinuation of breastfeeding and the top reason mothers stop breastfeeding in the hospital.[3] The first reason for discontinuation of breastfeeding is perceived low milk supply or doubt that baby is getting enough milk. This will be discussed later in this chapter. Early assessment and management of the nipple or breastfeeding pain is crucial to prevent discontinuation of breastfeeding.[6]

The best prevention of nipple pain and soreness is proper positioning of the baby on the breast. To feed effectively, the baby needs to draw the breast deeply into the mouth, so that the mother's nipple approximates to the junction of the hard and soft palate.[7] This enables the baby to use its tongue smoothly and rhythmically against the under surface of the breast and remove milk from the ducts. With a good latch, the mother's nipple is so far back in the baby's mouth that it is beyond the reach of the compression wave of the tongue, so no pain is caused, and no damage is done. If a woman is experiencing pain, a lactation consultant or a health-care professional well trained in lactation should obtain a maternal history, perform a physical assessment of both the mother and baby, and observe the mother nursing her baby. The International Board Certified Lactation Consultant (IBCLC) provides professional management of clinical lactation issues that are evidence based. The IBCLC has passed an international exam after taking qualified education courses and obtained clinical hours. Most IBCLC are nurses and dietitians working in hospitals and clinics. Breastfeeding educators also provide education and support for lactation issues. They are certified after attending a course and passing an exam following the course. Peer counselors also provide breastfeeding support. They have classroom training, mentoring from LC, and skills pass off requirements. The lactation consultant can determine whether the pain is simply related to breastfeeding a new baby, or if a problem exists. Persistent nipple pain has been associated with postpartum depression as well as increased stress.[3,8] Assessment of maternal mental health symptoms and professional referral may be appropriate.

The main causes of persistent nipple pain are trauma from poor positioning of the infant at the breast, poor

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latch, improper release of suction after a feed, infection (thrush or *Staphylococcus aureus*), pumping with too much suction or incorrect breast flange size, a disorganized or dysfunctional suck, neonatal **ankyloglossia,** and dermatologic abnormalities.[4,8,9] Nipple damage can occur even prior to discharge from the hospital.[3,10] Breast care and cleaning rituals can also contribute to nipple soreness. Proper cleaning of the lactating breast involves only daily washing with warm water. Soaps and other cleansing products can irritate the nipple, and some creams and lotions can cause an allergic reaction and skin irritation. Plastic-backed breast pads used to prevent milk leakage can trap moisture and inhibit airflow to the nipple.[4]

Women can take simple steps to manage nipple pain. Recommended strategies include letting breasts air-dry after nursing, rubbing expressed milk or an all-purpose ointment (not petroleum-based) on nipples, and using warm compresses on sore nipples.[3,4] The common belief that limiting the frequency or duration of feedings will prevent or heal sore nipples is not substantiated by the literature.[10] Use of a pump to express milk can help maintain supply if the nipples are so sore that the mother cannot nurse.[7,11] However, the suction on the breast pump should be adjusted carefully. High suction can make nipples sore and red and even cause blisters.

Flat or Inverted Nipples

Some women have flat or inverted nipples, which do not extend very far into the baby's mouth. This should not impact breastfeeding if the latch is correct as the majority of women with flat or inverted nipples are able to breastfeed successfully.[8] If the baby is struggling with latch, instruct the mother with flat nipples to roll her nipple between her fingers or use a breast pump prior to feeding to help draw out the nipple. Nipple shells used between breastfeedings may be helpful to draw out the nipple as well. Nipple everters and nipple enhancers, commercial products available for flat or inverted nipples, are also showing benefits for mothers with flat or inverted nipples.[8,9]

Small or Large Nipples

Small or large nipples do not usually impact breastfeeding. The lactating mother with small nipples should be encouraged to compress her breast and use the hand grasp that allows her baby to latch with as much breast tissue as possible. Large nipples may cause breastfeeding difficulties when the infant is small. A study by Vazirinejad et al. reported infants born to mothers with breast/nipple variations including flat nipples, inverted nipples, and large nipples had lower weight gain in the first 7 days of life compared to infants born to mothers without breast/nipple variations.[12,13]

Letdown Failure

> "After she latches on, take deep, long breaths—think yoga not Lamaze when you nurse. As you exhale, visualize the milk letting down through your breasts into the baby's mouth."
>
> —C. Martin and N. F. Krebs[11]

Letdown failure is not common,[13] but because letdown is necessary to successful breastfeeding, it is important to address the matter. Stress may inhibit oxytocin, as well as alcohol and distractions. Oxytocin nasal spray can be prescribed by a physician for letdown failure. The synthetic oxytocin is sprayed into the nose and stimulates letdown, but it can only be used for a few days to help women get through a tough time. Other methods should be used at the same time to stimulate letdown. Prolonged letdown failure will cause lactation suppression.[5] Martin and Krebs[11] recommend a number of techniques to help women relax and enhance letdown:

- Play soothing music that the mother can focus on while nursing.
- Have the partner rub his knuckles down her spine.
- Try different nursing positions.
- Get out of the house. Most babies enjoy a walk.
- Arrange for some time alone (a few hours).
- Decrease number of caffeinated beverages and increase water consumption for a few weeks.

Hyperactive Letdown

Hyperactive letdown can also be a problem, especially among first-time mothers. When letdown is overactive, milk streams from the breast as feeding begins. Milk may also leak from the breast that the infant is not being nursed from. The milk streams quickly, and the infant may be overwhelmed by the volume. The infant may choke, cough, or gulp to keep up with the flow. When the infant gulps, the infant may take in air, develop gas pain, and then become fussy.

Management includes removing the infant from the breast when letdown occurs and waiting for the milk flow to slow down before putting the infant back to the breast.[5] The mother can also express 5 to 10 mL before breastfeeding and if her infant continues to struggle, she can express her milk until the flow slows.[12] (Expressed milk can be frozen for later use.) Expressing milk also allows infants to get hindmilk and prevents gas and colic that may result from a large volume of relatively low-fat milk.

ankyloglossia (tongue-tie) A congenital condition of a tight or short frenulum that causes tongue restriction and range of motion.

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Hyperlactation

Hyperlactation occurs when the milk volume being produced by the mother far exceeds the intake of the baby. A hyperactive letdown may be a sign of overproduction. Other signs include breasts that are not drained completely during a feeding, chronic plugged ducts, **milk blebs or milk blisters**, mastitis, leaking in between feedings, and pain with letdown or deep in the breast. Symptoms in the baby include those already mentioned with hyperactive letdown, as well as spitting up, poor weight gain due to the high volume of low-fat milk, or good initial weight gain followed by poor weight gain. During the feeding, the baby may have difficulty maintaining latch and may also arch back off of the breast, or refuse the breast.[2,14] Other symptoms in the baby may include excessive fussiness and/or excessive gas and green, frothy explosive stools due to rapid transit time. These symptoms often lead the mother to incorrectly limit her intake of milk or other foods, believing the symptoms are caused by an allergy instead of a foremilk/hindmilk imbalance. If intake of high volume of low-fat foremilk continues over time, the baby may develop colitis.

Management in the mother is to reduce production. This can be done by having the baby nurse on only one side during feedings and having the mother express milk on the other side only for comfort. Cabbage leaves or cold compresses may also be used to decrease production. Encourage the mother to try the laid-back nursing position to reduce flow rate. If baby is experiencing fore-milk/hind-milk imbalance, instruct mother to massage breast carefully before feeds to maximize fat content of the milk.[15]

Engorgement

Engorgement occurs when breasts are overfilled with milk. This is common during the first week of the birth and in first-time mothers.[16] Engorgement occurs when the supply-and-demand process is not yet established, and the milk is abundant. It also occurs with infrequent or ineffective removal of milk from the breast because of mother–infant separation, a sleepy baby, sore nipples, or improper breastfeeding technique.[4] The best way to prevent engorgement is to nurse the infant frequently. Newborn infants will often nurse every hour and a half. If the infant is not available to nurse, expressing milk every few hours will prevent engorgement while helping to build and maintain a milk supply.

The peak time for engorgement varies among women and can occur any time from day 2 through day 14 but is most common on days 3–5.[17] Engorgement can result in discomfort, difficulty in establishing milk flow, and difficulty in latch-on.[14,17] Severe engorgement inhibits milk flow because the swollen tissue is compressing the milk ducts—not because the mother is failing to experience the letdown or milk ejection reflex. Once engorgement occurs, there are several simple treatments to help ease the discomfort. It is important for the mother to express milk until her breasts are no longer hard before putting the infant to breast. This will make it more comfortable for her and easier for her baby to latch on. The use of hand expression or an electric breast pump can help establish milk flow and soften the breast to make it easier for the infant to attach properly and further extract milk. Women can use analgesics to reduce pain from engorgement. A warm shower or warm compresses with massage before feedings may be helpful to relieve pressure and trigger milk flow. Application of cold compresses or gel packs between feedings helps reduce pain and swelling.[4,16]

milk bleb/milk blister A tender inflammatory area sealed off by the epidermis on the nipple that is white or yellow area.

Cabbage Leaves Many believe that cabbage leaves (either cool or at room temperature) reduce discomfort and swelling associated with engorgement, although it is not known how the effects are mediated. In randomized trials, cabbage leaves and gel packs were equally effective in the treatment of engorgement, as were cabbage extract and a placebo cream.[16] The Academy of Breastfeeding Medicine suggests these treatments may help discomfort but not actually relieve engorgement.[17] Raw cabbage leaves are applied directly to the breast until they wilt, which is approximately 20 minutes.

Plugged Duct

An obstructed, or *plugged*, duct is a localized blockage of milk resulting from milk stasis (milk remaining in the ducts).[4] The mother may feel a painful knot in one breast but usually does not have a fever or other signs of illness. This pain can be significant. Treatment for plugged ducts is gentle massage, warm compresses, and complete emptying of the breast.[4,11] If the plugged ducts are being caused by hyperlactation, treatment should also include resolution of overproduction.[2] Women should consider changing nursing positions to facilitate emptying of the breast. For example, if the woman is nursing while lying down, she may try a sitting position, or she may switch the position of holding the infant (refer to Figure 6.4 in Chapter 6). If the woman is pumping, the flange size should be assessed. In most cases, using a larger size flange will improve efficiency of pumping. When plugging occurs repeatedly, a gentle manual massage before nursing often results in the plug being expelled. Consider use of lecithin for chronic plugged ducts. Lecithin is a phospholipid used as an emulsifier to keep fat dispersed and suspended in water instead of building up in the ducts. One tablespoon per day of oral granular lecithin has been reported an effective therapy. If not resolved, plugged ducts lead to mastitis.[18]

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Mastitis

Mastitis is an inflammation or bacterial infection of the breast most commonly found in breastfeeding women. It can be infective or noninfective. It occurs in about 3 to 20 percent of breastfeeding women.[12] This range is large and depends on breastfeeding duration.[14,18] Mastitis can occur any time during lactation. The higher percentages of mastitis occur 2–3 weeks after birth with the majority of cases occurring within the first 12 weeks.[4,18] Some women get mastitis after having cracked or sore nipples, and some get it without any noticeable problem on the surface of the breast. Missing a feeding or the infant sleeping through the night may precipitate engorgement, plugged ducts, and then mastitis. Restriction from a tight bra or clothing may also increase risk of developing mastitis. Symptoms of mastitis are similar to those of a plugged duct (Table 7.1). In both conditions, there is a tender, hot, enlarged, hard, wedge-shaped area in the breast, and often an area of redness on the surface of the breast. Cases of mastitis are usually accompanied by a fever and flu-like symptoms. The Academy of Breastfeeding Medicine clinical protocol on mastitis indicates that there is a spectrum of conditions ranging from edema and ductal inflammation to bacterial mastitis and an abscess.[19]

It is important for the mother to continue nursing through mastitis and to understand that mastitis is not contagious and does not make her milk harmful. Effective milk removal is the most important management step in mastitis. If nursing is too painful, the mother should express milk from the breast by hand or pump. The techniques used to minimize pain from engorgement may also be used for mastitis. Nonsteroidal anti-inflammatory drugs like Ibuprofen are commonly recommended to help with the pain and inflammation.[19] Adequate rest, fluids, and nutrition are also important. In cases of inflammatory mastitis caused by increased ductal narrowing or when symptoms have been present for less than 24 hours, efficient milk emptying via frequent nursing or pumping may be sufficient to resolve the mastitis. The individual providing human milk feedings should receive psychosocial support along with breastfeeding support to prevent early weaning. Bacterial mastitis, according to the Academy of Breastfeeding Medicine Mastitis Spectrum Protocol, occurs when inflammatory mastitis progresses or when ductal narrowing is not resolved. Antibiotics are usually required to treat bacterial mastitis. In a randomized trial, half of 55 women treated only with antibiotics had breast abscess, recurrent mastitis, or symptoms lasting longer than 2 weeks, compared to only 2 of 55 who also emptied their breasts (breasts can be emptied by feeding the baby, hand expression, or pumping).[20] A limited number of studies have shown that probiotics may be an effective treatment option especially in chronic mastitis. More studies are needed on prebiotics and probiotics and their role as a treatment option for mastitis.[19]

Significant delays in seeking treatment for bacterial mastitis are often associated with the development of abscess and recurrent mastitis.[4] Lactating mothers who experience recurrent mastitis require evaluation to determine and resolve inciting factors. A medical examination is encouraged when systemic symptoms last longer than 24 hours. Medical professionals should also evaluate the

Table 7.1 Common breast problems and their symptoms

Characteristics	Engorgement	Plugged Ducts	Mastitis	Breast Abscess
Cause	Incomplete and/or inefficient milk emptying from baby or pump	Infrequent breast feeding/ pumping, incorrect flange size (pumping)	Unresolved plugged duct	Unresolved mastitis
Onset	Gradual, immediately postpartum	Gradual, after feedings	Sudden, after 10 days	Sudden, after 10 days
Breast Symptoms	Generalized swelling and hot area with pain in both breasts	Swelling may shift, little or no heat with mild focused pain in one breast	Localized pain and red, hot, swollen area usually on breast	Localized pain and, red, hot, swollen area on affected breast, tender lump
Temperature	<38.4°C (101°F)	No fever <38.4°C	Fever (>38.4°C)	Fever (>38.4°C)
Other Symptoms	Feels well	Feels well	Flu-like	Flu-like
Treatment	Increase frequency of breastfeeding or pumping Cold compresses, anti-inflammatory for pain, use heat, massage, and pumping before feeding as needed	Continue breast feeding, be sure to empty the breast, evaluate flange size Anti-inflammatory for pain Use warm compresses	Frequent pumping Anti-inflammatory for pain May need antibiotics	Doctor required to drain the abscess Anti-inflammatory for pain Antibiotics

Sources: http://women.webmd.com/blocked-milk-ducts-and-breast-feeding, http://www.nbci.ca/index.php?option=com_content&view=article&id=7:blocked-ducts-a mastitis&catid=5:information&Itemid=17, *Breastfeeding: A Guide for the Medical Professions*, 9th ed., by R. A. Lawrence and R. M. Lawrence, Table 16.1 © 2021.

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mother with recurrent mastitis for anxiety and perinatal mood disorders as this group experiences an increased incidence of mastitis spectrum conditions.[19] Abrupt weaning is not recommended and increases risk of abscess development (refer also to Case Study 7.1). Vertical transmission of human immunodeficiency virus (HIV) from mother to child increases during mastitis infection. The World Health Organization (WHO) recommends HIV-positive mothers avoid breastfeeding on the affected side until the infection resolves.[16]

Case Study 7.1 Chronic Mastitis

This was an unremarkable first pregnancy for 29-year-old Jamie. Jamie has reported experiencing "a little" breast enlargement during her pregnancy.

Her infant is first put to the breast at 2 hours' postpartum, and the infant latches well according to mom, and suckles vigorously. The infant nurses every 2 hours over the first 3–4 days' postpartum. Jamie's breasts became noticeably fuller during the third postpartum day, and by the fourth postpartum day they are painfully engorged. In addition, Jamie reports painful, burning, cracked nipples. The engorgement makes it difficult for her baby to latch at the breast. The baby becomes irritable, and Jamie experiences a significant amount of pain. Prior to discharge from the birth facility, Jamie received educational materials on breastfeeding which included a section on engorgement that Jamie reviews.

On day 5, the engorgement is still causing discomfort. Jamie's nipples have become more cracked and painful so she schedules an appointment with a lactation consultant. The lactation consultant observes breastfeeding and notes that the infant's latch has become shallow and tight. The shallow latch could be related to the engorgement or possibly an attempt to control the flow of milk. However, the infant shows all the signs of adequate intake, including 10 very wet and 5 soiled diapers during the 24 hours prior to the consultation per information Jamie has kept and shown to the lactation consultant. The lactation consultant provides Jamie with tips and techniques to improve her baby's latch and milk transfer, and to resolve the engorgement.

By day 12 postpartum, Jamie has inflammatory mastitis based on systemic symptoms she reported to her medical professional. She is treated with nonsteroidal anti-inflammatory drugs and encouraged to feed her baby on demand. She is also encouraged to minimize breast pumping, and to avoid deep massage of the inflamed breast tissue. A lactation consultant assists Jamie in achieving a proper infant latch and reviews postpartum breast anatomy.

By day 14, Jamie is feeling much better. The inflammatory mastitis is resolving, and her nipples are healing. She still has tenderness during infant feedings and a healing crack on the right side. Her breasts are still uncomfortably full and are occasionally swollen and tender.

At 3 weeks' postpartum, Jamie develops an inflamed area on the right breast that remains red and tender despite applying warmth and massage to the area. The lactation consultant helps Jamie to position the infant in a way that allows drainage of the inflamed area and recommends she pump the affected side to relieve the discomfort if breastfeeding is too painful. The crack on the right nipple has improved, but is still not completely healed. Jamie continues to show signs of oversupply, such as breasts feeling uncomfortably full, even after feeding, and excessive milk leakage between feedings. The lactation consultant provides Jamie with techniques to decrease her overproduction.

At seven weeks postpartum, Jamie calls the lactation consultant to report another flare-up of mastitis that has not resolved with the recommendations from her first incidence of mastitis. Her health-care provider performs a medical examination and evaluation for anxiety and perinatal mood disorders. Jamie is prescribed a 10-day course of dicloxacillin to treat bacterial mastitis and encouraged to use a probiotic. At 8 weeks' postpartum her mastitis resolved; her nipple pain is still present, but improving. Jamie is nursing the infant on one side only per feeding and reports that the infant latches better when she is in a more reclined position.

Source: Adapted from Anonymous. Case management of a breastfeeding mother with persistent oversupply and recurrent breast infections. *J Hum Lact.* 2000; 16:221–225; Lawrence and Lawrence, *Breastfeeding A Guide for the Medical Professional 2021*;[12] and Academy of Breastfeeding Medicine Protocol #36: Mastitis Spectrum.[19]

Questions

1. Name the causes of engorgement.
2. List at least two possible nutrition diagnoses for this case.
3. Identify at least one nutrition intervention for each diagnosis listed.
4. List potential indications for each intervention listed.



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Low Milk Supply

Real or perceived insufficient milk supply is the most common reason for cessation of breastfeeding.[3] The lactating mother with perceived low supply should be evaluated to determine factors related to perceived milk supply concerns. In addition, she should be reassured that her supply is sufficient for her infant and typical feeding frequency, stooling frequency, and typical baby behaviors reviewed. Low milk supply is usually caused by the mother not breastfeeding or pumping often enough or inefficient draining of the breast caused by a poor latch or incorrect flange size while pumping. Stress may also contribute to a low milk supply.[21] The mother may wish to use a **galactogogue**, which is a drug or herb used to increase milk supply. Galactogogues should be used only after evaluating maternal causes for low supply and when increasing breastfeeding and/or pumping has not been successful. According to the Academy of Breastfeeding Medicine, caution should be used when recommending galactogogues due to potentially serious side effects.[22] Encourage the mother to nurse or pump using a hospital-grade electric breast pump every 2–3 hours during the day and once at night. If the baby is not nursing effectively, the mother may need to pump after breastfeeding to improve her supply. Make sure her diet is adequate and her fluid intake is appropriate. Encourage resting and relaxation techniques. Review current medication and hormonal contraceptives. Estrogen is known to inhibit lactation. Progesterone-only birth control pills have been used without problems on milk supply.[23]

Common medications used as galactogogues are Metoclopramide (Reglan) and Domperidone (Motilium). Both medications increase prolactin levels through dopamine receptors. Using these medications as galactogogues constitutes "off-label" use because they have not been approved in the United States or most countries for increasing milk supply.[22] Metoclopramide is the most commonly used medication in the United States for Improving milk supply.[22] It is prescribed by a physician, who should also follow the mother for potential side effects. Metoclopramide may cause fatigue and drowsiness as well as diarrhea. Increased depression, anxiety, confusion, dizziness, or headache may also occur. A black box warning by the U.S. Food and Drug Administration (FDA) has been issued warning regarding long-term or high-dose use of Metoclopramide. Tardive dyskinesia (involuntary and repetitive movements of the body) has been linked to Metoclopramide use even when the drug is discontinued. Side effects should be reported to the prescribing physician. It may be necessary for the mother with these side effects to discontinue use of the medication. Domperidone is not an approved prescription drug in the United States except for specific circumstances. It is commonly used outside the United States as an anti-nausea treatment. In September 2011, the FDA granted Domperidone orphan drug status.[24] Domperidone appears to be safe and effective in improving milk production in a randomized control study.[22] Side effects are not common with Domperidone, however, there is evidence that use of domperidone may increase the incidence of ventricular arrhythmias and sudden cardiac death especially in unwell and older adults. Domperidone has also been shown to increase the QTc interval. The implications and risk for postpartum women without history of ventricular arrhythmias appears to be small. The use of Domperidone to increase milk supply has explicit recommendations against this use by the FDA. The Academy of Breastfeeding Medicine Protocol Committee stresses before prescribing these pharmaceuticals, possible side effects need to be considered against the possible benefits.[22]

Fenugreek (*Trigonella foenum-graceum*), goat's-rue (*Galega officinalis*), and milk thistle (*Silybum marianum*)/blessed thistle (*Cnicus benedictus*) are common herbal galactogogues that have been used throughout history.[22] It is important to inform the mother that most herbal or natural galactogogues have not been evaluated scientifically for their safety or effectiveness and are not regulated by the FDA. Galactogogues are used in the short term (1–3 weeks). Studies are lacking on potential side effects of longer-term use. These products are discussed further in the "Herbal Remedies" section of this chapter. The Academy of Breastfeeding Medicine Protocol Committee recommends to clinicians prescribing galactogogues to use caution regarding drug-to-drug or drug-to-herb interactions and to inform mother of the risks and potential benefits of the use of galactogogue. The committee also recommends close follow-up of both the mother and infant for potential adverse effects and the status of lactation.[22]

7.2 Maternal Medications

> "It is equally inappropriate to discontinue breastfeeding when it is not medically necessary to do so as it is to continue breastfeeding while taking contraindicated drugs."
>
> —R. A. Lawrence[25]

The single most common medical issue health-care providers face in managing breastfeeding patients is maternal medication use.[12] Approximately 94 percent of pregnant or breastfeeding women receive some type of medication.[26,27] Most medications taken by nursing mothers are excreted in breast milk. These include both over-the-counter (OTC) medications and prescription drugs. Unfortunately, data

galactogogue A medicine or herbal substance taken with the belief to increase milk supply. It may also be taken to help with breastmilk initiation and maintenance.[21]

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Table 7.2 Resources on drugs, medications, and contaminants in human milk

• Sachs, H. C., and the AAP Committee on Drugs. Clinical report: The transfer of drugs and therapeutics into human milk: An update on selected topics. *Pediatrics*. 2013; 132:e796–e809.[33]
• http://pediatrics.aappublications.org/content/108/3/776.full.pdf+html
• Briggs, G. G., Freeman, R. K., & Yaffe, S. J. *Drugs in Pregnancy and Lactation*, 9th ed. (Baltimore, MD: Williams and Wilkins, 2011).[30]
• Hale, T. W. *Medications and Mothers' Milk,* 19th ed. (New York, NY: Springer Publishing Company, 2020). Dr. Hale will answer questions from health professionals posed on the Pharmasoft website: www.iBreastfeeding.com.
• *Breastfeeding and Maternal Medication: Recommendations for Drugs in the Eleventh WHO Model List of Essential Drugs*.[34] UNICEF World Health Organization, 2003. www.who.int/child-adolescent-health/New_Publications/NUTRITION/BF_Maternal _Medication.pdf.
• Blumenthal, M., Busse, W., Goldberg, A., et al., eds. *The Complete German Commission E Monographs: Therapeutic Guide to Herbal Medicines*. (Boston, MA: Integrative Medicine Communications, 1998).[30]
• The Breastfeeding and Human Lactation Center, University of Rochester. This service is available for complex medication questions (9:30 a.m. to 4 p.m. EST, Monday to Friday, at 585-275-0088).
• HerbMed (www.herbmed.org): an interactive, electronic herbal database with links to scientific publications.
• Humphrey, S. *The Nursing Mother's Herbal*. (Minneapolis, MN: Fairview Press, 2003).
• TOXNET: National Library of Medicine Drug and Lactation database, containing summaries of published literature on the effects of over 400 drugs on lactation.
• REPROTOX: An online proprietary reproductive toxicology database, http://reprotox.org.

on drug safety may not be readily available to women and health-care providers.[28] The FDA implemented new labeling for prescription medications used during pregnancy and lactation in 2015 known as the PLLR. The PLLR renamed the Nursing Mothers section to Lactation and is required to include information regarding the amount of drug in breast milk as well as any potential side effects if available. Updated information is to be added to the label when it becomes available.[29] Some mothers who discontinue breastfeeding prematurely reported concern about the use of medications as a major reason.[27] Recommending that an individual providing human milk discontinue breastfeeding to take a medication is almost never required and should only be done as a last resort. For most maternal conditions, required drug therapy choices are available that will not cause harm to the infant.[27,30]

milk/plasma ratio The ratio of the concentration of drug in milk to the concentration of drug in maternal plasma.[27] Since the ratio varies over time, a time-averaged ratio provides more meaningful information than data obtained at a single time point. It is helpful in understanding the mechanisms of drug transfer and should not be viewed as a predictor of risk to the infant, as it is the concentration of the drug in milk, and not the M/P ratio, that is critical to the calculation of infant dose and assessment of risk.[27,32,33]

exposure index The average infant milk intake per kilogram body weight per day × (M/P ratio ÷ Rate of drug clearance) × 100. It is indicative of the amount of the drug in the breast milk that the infant ingests and is expressed as a percentage of the therapeutic (or equivalent) dose for the infant.[21]

Two key questions to address in the analysis of the risk of an infant's exposure to a drug excreted in breast milk are: How much of the drug is excreted in milk, and at the level of excretion, what is the risk of adverse effects?[31-33] Among the numerous variables to examine to answer these questions are:

- The pharmacokinetic properties of the drug
- Time-averaged breast **milk/plasma ratio** of the drug
- The drug **exposure index**
- The infant's ability to absorb, detoxify, and excrete the agent
- The dose, strength, and duration of dosing
- The infant's age, feeding pattern, total diet, and health[26,28]

Additional considerations are the well-established interethnic and racial differences in drug responsiveness, exposure of the infant to the drug during pregnancy, whether the drug can be safely given to the infant directly,[26] and the relative infant dose.[27] The ultimate test of drug safety is the measurement of the infant's plasma drug concentration and any side effects from the drug on the infant.[31] Carefully controlled studies on large enough samples to validate the results are rare but have increased during the last decade. Use of the risk–benefit algorithm for assessment of drug use in breastfeeding may also be helpful.

Fortunately, numerous resources (Table 7.2)[30,32,34] based on a thorough evaluation of available evidence can assist the health-care provider and mother in identifying which drugs are safe and which are not. The American Academy of Pediatrics (AAP) Committee on Drugs publishes

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guidelines for practitioners.[32,35,36] These guidelines provide a list of drugs divided into the following seven categories according to risk factors in relationship to breastfeeding:

1. Cytotoxic drugs that may interfere with the cellular metabolism of the nursing infant
2. Drugs of abuse for which adverse effects on the infant during breastfeeding have been reported
3. Radioactive compounds that require temporary cessation of breastfeeding
4. Drugs for which the effect on nursing infants is unknown, but may be of concern
5. Drugs that have been associated with significant effect on some nursing infants and should be given to nursing mothers with caution
6. Maternal medications usually compatible with breastfeeding
7. Food and environmental agents having no effect on breastfeeding

The list, which is updated periodically, includes only those drugs about which there is published information. Other useful monographs and review articles provide additional information on a wide array of medications.[27,31,35]

The Breastfeeding and Human Lactation Study Center at the University of Rochester (Table 7.2) continually updates its database of more than 3,000 references on drugs, medications, and contaminants in human milk and is a resource for complex questions on the risks to the breastfed infant. The TOXNET LactMed database is available online (https://support.nlm.nih.gov/). There are also textbooks with information on drugs and breastfeeding. *Medications and Mother's Milk* by Thomas Hale (Table 7.2) is updated regularly. It includes information on prescription and OTC medications as well as common herbal remedies.[27] The *Physician's Desk Reference (PDR)* is not a good source for information about drugs and breastfeeding because the information is derived directly from pharmaceutical companies whose first concern is avoiding liability. When there are no studies that prove beyond a doubt that a drug is safe for nursing mothers, the drug companies must advise against use while breastfeeding—even if what is known about the drug suggests that there is little cause for concern.

Medications contraindicated during breastfeeding include antineoplastic agents, radioactive isotopes, drugs of abuse, and drugs that suppress lactation.[26,27,32] Fortunately, safer alternative medications can be recommended as a substitute for most other drugs with known adverse effects on infants. Specific knowledge about a medication's safety during breastfeeding will allow proper treatment and avoid unnecessary maternal anxiety and undue risk. For example, many cold remedies, antihistamines, and decongestants are listed as usually compatible with breastfeeding, but they may suppress lactation. In a study of women who took a single 60 mg dose of Sudafed (Pseudoephedrine), 24-hour milk production was decreased by 24 percent.[27] This medication should be avoided in mothers with marginal or low production. The mother taking such medications should closely monitor milk production.

Many women have questions on the safety of oral contraceptive use during lactation. There is currently no evidence of harm, but few women have been studied. There is evidence that combined oral contraceptives that contain both estrogen and progesterone may reduce the volume of breast milk.[27,37] The American College of Obstetricians and Gynecologists (ACOG) and the WHO recommend against using combined oral contraceptives in the first 6 weeks' postpartum. If lactation is well established at 6 weeks, ACOG recommends monitoring the infant's nutritional status if combined oral contraceptives are initiated.[38] The WHO does not recommend using combined oral contraceptives from 6 weeks to 6 months unless other forms of contraceptives are not available. The La Leche League International recommends avoiding combined oral contraceptives while breastfeeding because other forms on contraception are available.[38] Progestin-only oral contraceptives and implants are safe and effective during lactation.[27,37] Implants that deliver orally active steroids should only be used after 6 weeks postpartum to avoid transferring of steroids to the newborn.[37] The Depo-Provera shot is also recommended at 6 weeks' postpartum.[27]

If a drug or surgery is elective, a mother may be able to delay it until the baby is weaned. If a breastfeeding mother needs a specific medication, and the hazards to the infant are minimal, she should be instructed to take the medication after breastfeeding, at the lowest effective dose, and for the shortest duration.[2,6,39] Other important steps can be taken to further minimize the effects (Table 7.3). It is also sometimes possible to choose alternative routes for administration of a medication to reduce exposure. For example, prescribing an inhalant instead of a drug taken by mouth, or a topical application rather than oral dosing,

Table 7.3 Minimizing the effect of maternal medication[24]

1. *Avoid long-acting forms:* Accumulation in the infant is a genuine concern because the infant may have more difficulty excreting a long-acting form of a drug, which usually requires detoxification in the liver.
2. *Schedule doses carefully:* Check usual absorption rates and peak blood levels of the drug, and schedule the doses so that the least possible amount gets into the milk. To minimize milk levels of most drugs, the safest time for a mother to take the drug is usually immediately after her infant nurses.
3. *Evaluate the infant:* Watch for any unusual signs or symptoms, such as changes in feeding pattern or sleeping habits, fussiness, or rash.
4. *Choose the drug that produces the least amount in the milk.*

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reduces infant exposure. If a drug is to be taken for diagnostic testing (such as a radioactive agent) or procedure, a mother may need to withhold breastfeeding for a short period of time, pumping and discarding her milk during that time period. The mother can plan ahead in these cases and pump prior to the procedure or surgery. She can freeze her expressed milk for use while breastfeeding is withheld. Discontinuing breastfeeding due to maternal medications is a last resort but may be necessary for the health and well-being of the mother (e.g., if she needs chemotherapy or radioactive treatment). Any decision to limit a mother's breastfeeding must be justified by the fact that the risk to her baby clearly outweighs the benefits of breastfeeding.

7.3 Herbal Remedies

Numerous herbs have been used in folk and traditional systems of healing to affect the flow of milk (Table 7.4), or to treat mastitis, infant colic, and thrush.[40–43] However, scientific information about herb use during lactation, particularly from recent studies, is sparse. The limited pertinent safety data are based on traditional use, animal studies, and knowledge of the pharmacologic activities of the products' constituents. The 2018 Academy of Breastfeeding Medicine Protocol revision on use of galactogogues has shifted the attitude of galactogogue use to one of more caution as more significant side effects have been documented for some of them.[22] Medicinal herbs should be viewed as drugs, with evaluation of both their pharmacological and toxicological potential.[1,14,44]

A mother may perceive herbs as natural and therefore safe and even preferable to conventional OTC medicines or prescription drugs. However, the risks of using some herbal remedies may outweigh the potential benefits. The same risk factors that apply to drugs also apply to herbs. *Medications and Mother's Milk* (2021) contains a systematic lactation risk analysis of numerous herbal remedies. Many herbs are far from benign, and many are contraindicated during lactation (Table 7.5). Because little is known about the amount secreted in human milk or the effects on preterm or term infants, herbs that are central nervous system stimulants, herbs that destroy cells (cytotoxic), or herbs that are laxatives, hepatotoxic, carcinogenic, mutogenic, or contain potentially toxic essential oils are not recommended during lactation.[41-45]

The toxic effects of herbs are often not due to the herb itself, but are caused by products containing misidentified plants or contaminants such as heavy metals, synthetic drugs, microbial toxins, and toxic botanicals.[46] **Medicinal herbs** in the United States are regulated as dietary supplements and are not tested for safety or efficacy.

medicinal herbs Plants used to prevent or remedy illness.[43]

Herbal teas that are safe for the infant and mother during lactation are presented in Table 7.6. Lawrence and Lawrence[12] recommend using only herbal teas "that are prepared carefully, using only herbs for essence (e.g., Celestial Seasonings brand tea) and avoiding heavy doses of herbs with active principles." Careful attention should also be given to preparation, avoiding long steeping times.

Some culinary herbs may lead to problems when used extensively. In lactation and herbal texts, sage has a folk reputation for lowering milk supply,[41] as does parsley and peppermint, especially if the oil is taken by mouth in large doses.[47] Consumed on occasion, however, in small amounts as part of a reasonably varied diet, peppermint, parsley, sage, and other culinary herbs currently have no documented negative effect on lactation.

Although various herbal oils, gels, ointments, or creams are often suggested for use on the nipples, any substance applied to the breast or nipples could easily be ingested by the nursing child. The use of herbal oils is not recommended.[47] In one infant, severe breathing difficulties were documented after the mother used menthol, a significant component of peppermint oil, on her nipples.[48]

Although health-care practitioners may wish otherwise, some mothers may refuse prescription drugs and

Table 7.4 Herbs traditionally used to affect milk production* [41,42]

Herbs to Promote Milk Flow
Anise
Astralagus
Milk thistle
Caraway
Celery root and seed
Chaste tree berry (chasteberry) or monk's pepper
Fennel
Fenugreek
Goat's-rue
Hollyhock
Hibiscus flower
Lemongrass
Marshmallow
Stinging nettle
Raspberry
Rauwolfia
Verbena
Herbs That Reduce Milk Flow
Castor bean
Jasmine flower
Fresh parsley
Sage

*Many traditional galactogogues are not currently considered appropriate during lactation and do not have conclusive safety and effectiveness (Table 7.5).

Source: M. L. Hardy. *Journal of Pharmaceutical Sciences*, American Pharmacists Association, 2000.

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Table 7.5 Medicinal herbs considered not appropriate for use during pregnancy or lactation* [26,45,49]

Agnus castus	Coltsfoot	Hawthorne	Pokeroot
Alkanet	Comfrey	Heliotropium	Poplar
Aloes	Cornsilk	Hops	Prickly ash
Angelica	Cottonroot	Horehound, black	Pulsatilla
Apricot kernel	Crotalaria	Horehound, white	Queen's delight
Aristolchia	Darniana	Horsetail	Ragwort
Asafoetida	Devil's claw	Hydrocotyle	Red clover
Avens	Dogbane	Jamaica dogwood	Roman chaparral
Basil	Dong quai	Joe-pye weed	Sassafras
Bladderwrack	Echinacea	Juniper	Senna
Blue flag	Ephedra (ma huang)	Kava kava	Shepherd's purse
Bogbean	Eucalyptus	Licorice	Skullcap
Boldo	Eupatorium	Liferoot	Skunk cabbage
Bonese	Euphorbia	Lobelia	Squill
Borage	Fennel	Male fern	St. John's wort
Broom	Feverfew	Mandrake	Stephania
Buchu	Foxglove	Mate	Stillingia
Buckthorn	Frangula	Meadowsweet	Tansy
Bugleweed	Fucus	Melilot	Tonka bean
Burdock	Gentian	Mistletoe	Uva-ursi
Calamus	German chamomile	Motherwort	Valerian root
Calendula	Germander	Myrrh	Vervain
Cascara	Ginkgo biloba	Nettle	Wild carrot
Cayenne pepper	Ginseng, eleuthero	Osha	Willow
Chamomile	Ginseng, panax	Passionflower	Wormwood
Chasteberry	Golden seal	Pennyroyal	Yarrow
Chinese rhubarb	Ground ivy	Petasites	Yellow dock
Cohosh, black	Groundsel	Plantain	Yohimbine
Cohosh, blue	Guarana	Pleurisy root	

*Exclusion from this list should not be a recommendation for safety.

insist on using herbal alternatives. It is estimated that 15–43 percent of breastfeeding mothers use herbal products.[43] If a mother is consuming a large amount of any herbal product, its contents should be checked. Important information to obtain on the product includes its name, a list of all ingredients, the names of the plants or other components (include the plants' Latin names, if possible), details of the preparation, and the amount consumed.[41] Reliable sources of herbal information[34,40,49,50] (Table 7.2) or the regional poison-control center may be

Table 7.6 Herbal teas generally regarded as safe during lactation[26]

Tea	Use	Common Uses
Rose hips	Vitamin C	Boost the immune system
Raspberry	Flavoring	Tone the uterus, increase milk production, decrease nausea, and ease labor pain
Red bush tea	Beverage	
Orange spice	Flavoring	
Peppermint	Flavoring (limit duration use)	Relieve nausea, morning sickness, and flatulence
Chicory	Caffeine-free coffee substitute	General health, constipation, improving bowel function

Sources: Based on data from *Breastfeeding: A Guide for the Medical Professions*, 9th ed. St. Louis: Mosby, Inc., 2021. "Herbal Tea and Pregnancy," American Pregnancy Association. Available at http://www.americanpregnancy.org/pregnancyhealth/herbaltea.html.

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able to identify potentially harmful pharmacological and toxicological ingredients.

In balancing the risks and benefits in a given situation, consideration should be given to the benefits of continued breastfeeding to the baby and the mother. It is also important to consider the varied nature of lactation: Newborns face different risks than do older babies or toddlers because of immaturity; infants consume varying amounts of human milk; mothers may be looking forward to many months of lactation yet need or desire the benefits of medicinal herbs. A few of the widely used herbs in the United States are discussed next.

Specific Herbs Used in the United States

Echinacea Echinacea is used for the common cold and to enhance the immune system. Insufficient reliable data are available on its entry into breast milk and effects on the infant. It is available in many forms; the tincture form contains 15–90 percent alcohol.[45] Gastrointestinal distress in some women has been reported. Consumption of echinacea during lactation is not recommended.[51]

Ginseng Root Ginseng root, widely believed to increase capacity for mental work and physical activity and to reduce stress, contains dozens of steroid-like glycosides, sterols, coumarins, flavonoids, and polysaccharides.[26] It is reported to have estrogen-like effects in some women, with breast pain common with extended use and mammary swelling also reported. While there has been considerable animal experimentation with ginseng root, human data are not extensive. There is no information on transfer to human milk.[45] The lack of standardized preparations, information on dosage, and accurate recording of side effects is a problem. Because of the reported breast effects and occasional reports of vaginal bleeding, the use of ginseng during lactation may not be advisable.[10,37]

St. John's Wort St. John's wort is widely used in the United States and Europe as a mood stabilizer and antidepressant. It has been shown to have fewer side effects in trials compared to prescription antidepressants.[27] Although the plant contains at least 10 classes of biologically active compounds, hypericin and hyperforin, and their metabolites pseudohypericin and adhyperforin, seem to be the most important for their neuropharmacologic properties.[52] There is growing evidence that hyperforin may be the key constituent responsible for the antidepressant property of this herb. Composition of St. John's wort preparations may vary based on climate and other variables related to growth, harvesting, and processing. Many products available in the United States and Canada may be of poor quality and contain little or no St. John's wort. The mother taking St. John's wort should only purchase from reputable sources. Large doses decrease prolactin levels, which could potentially reduce breast milk supply.[12,26] There are also concerns about the numerous potential herb–drug interactions because of the ability of St. John's wort to induce the metabolic activity of cytochrome P450 (CYP), particularly for drugs used to treat HIV.[52]

There is limited information on the excretion of active components in breast milk and effect on the infant. In a study of five mothers who were taking 300 mg of St. John's wort three times daily, hyperforin was excreted into breast milk at very low levels and the relative infant doses were 0.9–2.5 percent. This level of infant exposure to hyperforin through milk is comparable to levels reported in most studies assessing antidepressants or neuroleptics. No side effects were seen in the mothers or infants.[52,53]

St. John's wort may be a reasonable choice for treatment of mild postpartum depression using high-quality products.[27] Mothers who are breastfeeding while taking St. John's wort should be alert to changes in infant behavior and should be closely supervised by a pediatrician. If the mother is taking other medications or herbal supplements, she should be informed that drug–herb interactions are possible.

Fenugreek This spice is used as an artificial flavor for maple syrup, in teas, poultices, and ointments, and as an ingredient in East Indian cooking. It is also the most commonly used herbal galactogogue. While there are no scientific reports to support or reject this claim, there are anecdotal reports of its successful use to increase milk supply. In one account of 1,200 women taking fenugreek, almost all reported an increase in milk production within 24–72 hours.[54] Rare maternal adverse effects include diarrhea; a maple-like aroma in urine, breast milk, or sweat; and exacerbation of asthmatic symptoms.[55] This herb is derived from a plant in the same family as peanuts and chickpeas and has potential for allergy in sensitive infants. There are reports of colic, abdominal upset, and diarrhea among babies whose mothers took fenugreek.[45] Transfer into milk is assumed because the infant's urine smells of maple syrup. The usual dosage (2–3 capsules three times daily or 1 cup of tea three times a day) is considered compatible with breastfeeding.[55]

Goat's-Rue This is a widely used galactogogue in Europe and South America and is becoming increasingly popular in the United States. In the 1900s, cows fed goat's-rue were observed to have increased milk supply. No controlled human studies have been done. Only one side effect has been reported, according to the Academy of Breastfeeding Medicine. "Maternal ingestion of a lactation tea containing extracts of liquorice, fennel, anise, and goat's-rue was linked to drowsiness, hypotonia, lethargy, emesis, and poor suckling in two breastfed neonates. An infection

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work-up was negative, and symptoms and signs resolved on discontinuation of the tea and a two-day break from breastfeeding."[23] No other side effects in infants have been reported. The usual dose is 1 teaspoon dried leaves steeped in 8 oz of water for 10 minutes and used as a tea, with 1 cup taken three times per day.

Milk Thistle Milk thistle has been used in Europe and has become increasingly popular in the United States. It is often combined with fenugreek. There have been no randomized controlled studies done on this galactogogue. It is taken as a tea two to three times per day. The tea is usually prepared by simmering 1 teaspoon of crushed seeds in 8 oz of water. It is also available in capsules.

Many mothers may be taking herbal products for low milk supply. There are many other commonly used herbal galactogogues (Table 7.4). Keep in mind that there are few human studies done on most of these products. These studies often are small studies that are not well-designed and/or well-controlled[43] and based on expert opinion. Safety, proper dosing, and intended and unintended effects may be unknown.[18]

7.4 Alcohol and Other Drugs and Exposures

"Avoid prescribing or proscribing it [alcohol] and . . . assist the mother in appropriately adjusting her alcohol consumption in both timing and volume."

—R. A. Lawrence[12]

Alcohol

The harmful effects of alcohol consumption during pregnancy are well documented and drinking during pregnancy is not recommended. In the past, recommendations on alcohol consumption during lactation were ambiguous and somewhat controversial. Recommendations ranged from using alcohol as a galactogogue to complete avoidance. The AAP policy statement on "Breastfeeding and the Use of Human Milk" states, "Alcohol is not a galactogogue; it may blunt prolactin response to suckling and negatively affect infant motor development. Ingestion of alcohol should be minimized."[56] Alcohol consumed by the mother passes quickly into her breast milk, and the effects on the breastfeeding baby are directly related to the amount the mother consumes.[57,58]

The level of alcohol in breast milk matches the maternal plasma levels at the time of the infant feeding. Peak maternal plasma and breast milk levels are reached 30–60 minutes after alcohol consumption and approximately 60–90 minutes when taken with food.[12,57] As the alcohol clears from a mother's blood, it clears from her milk. It takes a 120-lb woman about 2–3 hours to eliminate from her body the alcohol in one serving of beer or wine (Table 7.7).[59] The common practice of pumping the breasts and then discarding the milk immediately after drinking alcohol does not hasten the disappearance of alcohol from the milk, as the newly produced milk will still contain alcohol as long as the mother has measurable blood alcohol levels.[57]

In many cultures, folklore passed down for generations encourages the use of alcohol as a galactogogue that facilitates milk letdown and rectifies milk insufficiency, as well as sedating and calming the "fussy" infant.[60] In contrast to this folklore, there is now strong evidence of a negative dose-related impact of alcohol on milk supply and the milk letdown reflex. In 2005, a study[60] found that during the immediate hours after alcohol consumption by lactating women, the hormonal milieu underlying lactation performance is disrupted. Oxytocin levels significantly decrease, whereas prolactin levels increase significantly. The diminished oxytocin response was significantly related to decreases in milk yield and milk ejection (letdown). The oxytocin release is blocked by alcohol.[26] In contrast, changes in prolactin were related to self-reported feelings of drunkenness. Recommending alcohol to women as an aid to lactation may be counterproductive; mothers may feel more relaxed, but the hormonal disruption diminishes the infant's milk supply.

Maternal alcohol consumption affects the odor of breast milk and the volume consumed by the infant within a half-hour to an hour after consumption.[16] Breast-fed infants consumed, on average, 20 percent less breast milk during the 3- to 4-hour period following

Table 7.7 Alcohol and breastfeeding: Time (h:min) until zero level in milk is reached for women at different body weights[59]

Maternal Body Weight		Time Alcohol Remains		
lb	(kg)	1 Drink	2 Drinks	3 Drinks
100	(45.4)	2:42	5:25	8:08
120	(54.4)	2:30	5:00	7:30
140	(63.5)	2:19	4:38	6:58
160	(72.6)	2:10	4:20	6:30
180	(81.6)	2:01	4:03	6:05

NOTE: Time is calculated from beginning of drinking. Assumptions made: alcohol metabolism is constant at 15 mg/dL; height of the women is 162.56 cm (5 ft, 4 in.). One drink 12 fl oz of 5% beer or 5 oz of 11% wine or 1.5 oz of 40% liquor. Example: For a 100-lb woman who consumed 2 drinks in 1 h, it would take 5 h 25 min for there to be no alcohol in her breast milk, but for a 180-lb woman drinking the same amount, it would take 4 h 3 min.

Source: Haastrup, M. B., Potteg, A., & Damkier, P. Alcohol and breastfeeding. *Basic & Clinical Pharmacol & Toxicol*. 2014; 114:168–173.

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their mothers' consumption of an alcoholic beverage (0.3 g ethanol/kg).[57,61] Compensatory increases in intake were then observed during the 8–16 hours after exposure when mothers refrained from drinking.[61]

Studies on the impact of maternal alcohol ingestion during lactation on infant sleep patterns and psychomotor development have raised concerns about regular consumption of alcohol while lactating. In one study, 11 of 13 breastfed infants had a reduction of more than 40 percent in active sleep after consuming their mothers' expressed breast milk flavored with alcohol (32 mg) on one testing day and expressed breast milk alone on the other.[62] All infants spent significantly less total time sleeping after consumption of the breast milk with alcohol (56.8 minutes with alcohol compared to 78.2 minutes without). A follow-up study replicated this finding and showed that infants can compensate for this deficit by increasing the amount of time spent in active (rapid eye movement) sleep during the 20.5 hours after the sleep-deficit period.[63] The investigators concluded that short-term exposure to small amounts of alcohol in breast milk produces distinctive changes in the infant's sleep–wake patterning. Since both the observed reduced milk consumption and the infant sleep deficits occur only when breastfeeding follows after the mother's alcohol consumption, a nursing woman who drinks occasionally can limit her infant's exposure to alcohol by planning in relation to her drinking and breastfeeding prior to drinking alcoholic beverages and using previously expressed human milk.[64] Epidemiologic data on the effects of moderate drinking throughout the lactation period on the human infant are limited. In a study of 400 infants born to members of a health insurance plan, no differences in the infant's cognitive development scores were found at 1 year of age between infants whose mothers consumed alcohol while nursing and those that did not. However, Bayley Psychomotor Development Index scores at 1 year of age were slightly lower among infants who were exposed to any alcohol through breast milk than among those who were not exposed.[65] Since current research does not show that occasional use (one to two drinks) of alcohol is harmful to the baby, La Leche League continues to support the opinion that the occasional use of alcohol in limited amounts is compatible with breastfeeding.[66] The AAP places alcohol in the category "Maternal Medication Usually Compatible with Breastfeeding."[32,35] It lists possible side effects if consumed in large amounts, including drowsiness, deep sleep, weakness, and abnormal weight gain in the infant. The Institute of Medicine Subcommittee on Nutrition During Lactation recommends that lactating women be advised that if alcohol is consumed, intake should be limited to "no more than 0.5 grams of alcohol per kilogram of maternal body weight per day."[67] For a 60-kg (132-lb) woman, 0.5 g of alcohol per kilogram of body weight corresponds to approximately 2–2.5 oz of liquor, 8 oz of table wine, or 2 cans of beer.[56,68] Many feel that nursing mothers are already placed under too many restrictions and may be discouraged from initiating or continuing to breastfeed if alcohol is prohibited because they feel they will face too many limitations.

If a mother does choose to have a drink or two, she can wait for the alcohol to clear her system before nursing according to the times given in Table 7.7. She can plan ahead and have alcohol-free expressed milk stored for the occasion. If she becomes engorged, she can pump her breasts as a means of comfort and discard her alcohol-containing milk. Drinking water, resting, or pumping and discarding breast milk will not hasten the removal of alcohol from the milk, as the alcohol content of milk matches the maternal plasma alcohol levels. Mothers who are intoxicated should not breastfeed until they are completely sober. Drinking more than two alcoholic drinks daily has been associated with decreased breastfeeding duration after 6 months by more than double compared to women who consumed less.[43] Breastfeeding should not be recommended for women who are chronic or heavy abusers of alcohol.[27]

Nicotine (Smoking Cigarettes)

Regardless of feeding choice (breast or bottle), the health risks for infants posed by having a mother who smokes are many, including otitis media, exacerbations of asthma, respiratory infections, and gastrointestinal dysregulation such as colic and acid reflux.[69] It is not ideal to smoke and breastfeed, but it is worse to smoke and not breastfeed. It is estimated that between 5 and 20 percent of breastfeeding mothers smoke.[26]

Well-documented data provide clear evidence that children of smoking mothers do better if breastfed in regard to general health, respiratory illness, and risk of sudden infant death syndrome (SIDS)[26,56] than if bottle fed. Unfortunately, women who smoke cigarettes are less likely to breastfeed than nonsmokers, are less likely to seek help with breastfeeding difficulties than nonsmokers, and are at increased risk for stopping breastfeeding by 3 months.[70] While lower milk output has been reported among smoking mothers,[70,71] it is unknown which components of cigarette smoke are responsible for the reduced milk production, and several studies provide evidence that smoking does not necessarily hinder breastfeeding.[71] Lower fat content in breast milk has been reported in smoking mothers. Lower fat concentrations are also observed in mothers who are exposed to second-hand smoke.[9] Breastfeeding infants whose mothers smoke show poorer growth. The reasons for this are not clear.[23,71] The AAP Breastfeeding Policy Statement lists "smoking as a risk factor for low milk supply and poor weight gain."[56] Changes in the odor and flavor of the breast milk might affect breast milk intake in the breastfed infant.[23,71] Mennella et al. found that sleep patterns were affected by smoking. They documented a dose–response effect with the greatest impact on sleep disruptions in the infants receiving the largest

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dose of nicotine via human milk.[72] Mennella et al. studied 15 mother/baby dyads whose mothers smoke. They documented infants of mothers who smoked consumed the same amount of milk as control infants; however, they spent more time awake and less time in both active and quite sleep time.[9]

Substantial epidemiological evidence suggests that social and behavioral factors and not physiological factors are largely responsible for the lower rates of breastfeeding found among smokers.[70] Some women believe that smoking is a barrier to breastfeeding; they do not believe they could, or should, adhere to the kinds of healthy practices they think are required of mothers to breastfeed.

Nicotine levels in breast milk of women who smoke are between 1.5 and 3.0 times higher than the level in the mother's blood, [32,70,72] and the mean 24-hour nicotine concentrations in breast milk rise as cigarette consumption increases. There is no evidence to document whether this amount of nicotine presents a health risk to the nursing infant, and because breastfeeding and smoking may be less detrimental to the child than bottle feeding and smoking, the AAP Committee on Drugs removed nicotine (and thus smoking) from its 2001 list of drugs of abuse with adverse effects on the infant during breastfeeding.[32]

Dahlstrom et al.[73] estimated that the dose of nicotine in breastfeeding infants was 1 µg per kilogram per feeding, based on data on nicotine concentrations in breast milk within 30 minutes after smoking. Women who smoke 10–20 cigarettes per day have 0.4–0.5 mg of nicotine/L in their milk. The authors indicated preterm infants and neonates receive larger dose of nicotine from breast milk compared to larger and older infants due to their lower body weight.[73] With gradual intake over a day's time, the infant can metabolize nicotine in the liver and excrete the chemical in the kidney. Numerous studies of nicotine and cotinine concentrations in the nursing mother and her infant confirm that although bottle-fed infants born to smoking mothers and raised in a smoking environment have significant levels of nicotine and metabolites in their urine, breastfed infants have higher levels.[71]

Tobacco smoking also increases the exposure of infants to organochloride pesticides, polychlorinated biphenyls (PCBs), and hexachlorobenzene through breast milk and second-hand smoke.[74,75] Women should be counseled not to smoke while nursing or in the infant's presence. Mothers who are not willing to stop smoking should cut down, consider low-nicotine cigarettes, and delay feedings as long as possible after smoking. The half-life of nicotine in human milk is 95 minutes.

When used as directed, smoking cessation aids that replace nicotine do not appear to pose any more problems for the breastfeeding infant than maternal smoking does.[70] Since transdermal nicotine (nicotine patch) provides a steady level of nicotine in plasma and thus in breast milk, the mother cannot control the level of nicotine in breast milk except by changing the strength of the patch. As the mother progresses through to lower patch strengths during smoking cessation therapy, the transfer of nicotine to the infant via milk decreases by as much as 70 percent.[70] Mothers who use nicotine replacement therapy intermittently (gum, nasal spray, or inhalation) might minimize the nicotine in their milk by prolonging the duration between nicotine administration and breastfeeding.[74] Safety of nicotine gum in lactation has not been determined.[9]

The lactating mother should be encouraged to stop smoking and if that is not possible, she should be encouraged to reduce smoking frequency and wait as long as possible after smoking to breasted. Educate mother on tips to reduce second hand smoke such as smoking, wearing a smoking jacket that is removed after smoking before holding her infant and not smoking in the car.

Electronic Cigarettes (e-Cigarettes)

Electronic cigarettes (e-cigarettes) have become increasingly popular in adolescents and young adults. They are also being used by cigarette smokers who are looking for less harmful nicotine alternatives.[76] Baeza-Loya et al. reported that e-cigarettes are more popular online than alternative tobacco products. One reason for this popularity is the perception that e-cigarettes are a safer smoking alternative because they don't have as many substances found in regular tobacco products. Any nicotine exposure during lactation should be discouraged, whether from traditional tobacco products or from e-cigarettes. Research is needed to determine the impact of e-cigarettes on breastfeeding as there remain numerous potential toxicities with inhaled aerosols. Many e-cigarettes contain unregulated and harmful chemicals, additives and toxins regardless of if they contain nicotine or are nicotine free. The impacts of heating and inhaling the two main ingredients propylene glycol and vegetable glycerine have yet to be studied in lactating women. E-cigarettes also contain heavy metals such as copper, lead, nickel, tin, and toxins like formaldehyde all which have been studied and have the potential to cause cancer and other adverse health effects.[77] McBride and Haile studied breastfeeding duration in women who used electronic nicotine delivery systems (ENDS) and reported only 40.8 percent breastfed for at least 3 months. They concluded use of ENDS was negatively associated with breastfeeding.[78] Breastfeeding mothers who are smoking or vaping e-cigarettes should be encouraged to stop smoking or reduce exposure to their infants. Instruct the breastfeeding mother to avoid smoking at least 30 minutes before breastfeeding and to breastfed right before smoking.

Marijuana

Marijuana is one of the most commonly used illicit drugs. It is inhaled, smoked, and orally consumed. Smoked cannabis contains over 150 known components.[79]

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Delta-9-tetrahydrocannabinol (THC), an active ingredient in marijuana, transfers and concentrates in breast milk and is absorbed and metabolized by the nursing infant. THC is highly lipophilic and can be stored in the brain and adipose tissue for weeks to months. One study showed that 1 hour after ingestion, there was an eightfold accumulation of THC in the breast milk compared to the maternal plasma level.[23,27] A study by Baker et al. showed THC concentrations in human milk peaked at 1 hour following inhalation and over the next 4 hours slowly decreased.[79] There is evidence from animal studies of structural changes in the brain cells of newborn animals nursed by mothers whose milk contained THC. Impairment of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) formation and neurotransmitter systems essential for proper growth and development has been described.[80] Significant absorption and metabolism has been shown in studies.[27] In one study following breastfeeding mothers and their infants for 12 months, marijuana exposure via the mother's milk during the first month postpartum appeared to be associated with a decrease in infant motor development at 1 year of age.[81] Concerns about marijuana use during lactation include the amount of the drug the infant ingests while nursing and the amount inhaled from second-hand smoke in the environment. Exposure in infants to marijuana via breast milk will provide positive toxicology urine tests for up to 2–3 weeks.[27] Urine toxicology screens do not differentiate the chronic user versus an occasional user. Careful consideration is needed to evaluate legal and health risks of not breastfeeding with marijuana use versus initiation and ongoing breastfeeding with maternal marijuana use. The possible effect on DNA and RNA metabolism should discourage any maternal use, especially since brain cell development is still taking place in the first months of life. Studies on marijuana use in pregnancy and lactation are showing concern for potential increased risks in behavior and neurodevelopmental problems. Many states have legalized use of THC for medicinal purposes and some states have legalized any use of this product. Despite being legal drug in many states, the AAP classifies THC as a drug of abuse that is contraindicated during lactation.[33] The Academy of Breastfeeding Medicine Protocol on substance abuse suggests counselling mothers to discontinue or restrict use of marijuana and to provide education on potential risks of use. The Academy of Breastfeeding Medicine states: "A recommendation of abstaining from any marijuana use is warranted. At this time, although the data are not strong enough to recommend not breastfeeding with any marijuana use, we urge caution."[82] The 2018 AAP Clinical Report on Marijuana Use During Pregnancy and Breastfeeding suggests mothers who are using marijuana abstain completely from use during lactation. The clinical report encourages breastfeeding mothers who do not abstain from marijuana use during lactation to reduce use and minimize infant to second-hand smoke exposures.[83] Studies are currently being conducted to further examine risks of THC exposure to the breastfed infant.

Caffeine

Although caffeine ingestion is a frequent concern of breastfeeding mothers, moderate intake causes no problems for most breastfeeding mothers and babies. A dose of caffeine equivalent to a cup of coffee results in breast milk levels of 1 percent of the level in maternal plasma and, consequently, low levels in the infant.[26] However, because the infant's ability to metabolize caffeine does not fully develop until 3–4 months of age, caffeine does accumulate in the infant. Within 15 minutes of consumption, caffeine is detectable in breastmilk. Caffeine levels peak around 1 hour after consumption.[84] Cases of caffeine excess in breastfed infants have been documented.[85] Symptoms, which include infants being wakeful, hyperactive, and fussy, did not require hospitalization and disappeared over a week's time after caffeine was removed from the maternal diet. No long-term effects of caffeine exposure during lactation have been documented.[84]

While most breastfed infants can tolerate a maternal caffeine intake equivalent to 3 cups of coffee per day, some babies may be more sensitive than others. If a mother suspects her baby is reacting to caffeine, she may try avoiding caffeine from all sources (coffee, tea, soft drinks, over-the-counter medications, chocolate) for 2–3 weeks.[66]

Other Drugs of Abuse

Amphetamines, cocaine, heroin, and phencyclidine hydrochloride (angel dust, PCP) are classified by the AAP[33] as drugs of abuse that are contraindicated during lactation. The AAP guidelines strongly state that these compounds and all other drugs of abuse are hazardous not only to the nursing infant but also to the mother's physical and emotional health. In addition to their adverse pharmacological effects on the mother and infant, street drugs lack standardization and may be contaminated with other active ingredients, bacteria, heavy metals, or pesticides.[68] The Academy of Breastfeeding Medicine has developed a clinical protocol addressing specific drugs and lactation in the *Clinical Protocol 21: Guidelines for Breastfeeding and Substance Use or Substance Use Disorder, Revised in 2015*.[82]

Opioids

Opioids are a group of pain-relieving medications. "Use of opioids in the United States has increased substantially over the last decade."[82] The Centers for Disease Control and Prevention (CDC) estimates that between 2008 and 2012, one-third of women of reproductive age filled an opioid prescription each year. Of concern is the growing number of opioid use disorders and overdoses in the United States. Low-dose prescriptions used for short periods of time have safely been used in breastfeeding mothers.[82] Amounts of

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opioids secreted in mother's milk are dose dependent.[26] Codeine should be used with caution as maternal metabolism impacts the amounts of codeine in mother's milk. The FDA announced in April 2017 recommendations against use of codeine and tramadol medicines in breastfeeding mothers.[86] These recommendations are due to reports of adverse event reports in individuals who metabolize codeine and tramadol faster than usual resulting in high levels. Side effects in infants include difficulty in breastfeeding, serious breathing problems, and excessive sleepiness. Adverse effects with tramadol have not been reported; however, the FDA reports that ultra-rapid metabolism can occur and has the same potential side effects as with codeine.[86] Breastfeeding mothers should be encouraged to discuss the use of pain medicines and alternatives to codeine and tramadol with their primary care provider.

Methadone

Rates of neonatal abstinence syndrome (NAS) continue to dramatically increase in the United States. This disproportionately affects public insurance-dependent populations who are non-White in rural areas. Increases in pharmacologic treatments were also associated with maternal food insecurity.[87] A meta-analysis completed by Chu et al. reported breastfeeding was associated with a decreased need of pharmacological treatment initiation and duration. The authors' also noted breastfeeding was also associated with shorter length of stay for infants with NAS and highlighted breastfeeding as a nonpharmacological intervention for NAS. Nonpharmacological interventions including skin-to-skin holding and breastfeeding are showing potential for improved outcomes for infants with NAS.[88]

The pharmacological treatment of choice for opioid dependence pregnant and postpartum breastfeeding women in the United States is methadone.[82] Methadone concentrations in human milk are low. According to the Academy of Breastfeeding Protocol 21 on substance abuse, "women on stable doses of methadone maintenance should be encouraged to breastfed if desired, irrespective of maternal methadone dose."[82]

Environmental Exposures

> "The advantages of breastfeeding far outweigh the potential risks from environmental pollutants. Taking into account breastfeeding's short- and long-term health benefits for infants and mothers, the World Health Organization (WHO) recommends breastfeeding in all but extreme circumstances."
>
> —World Health Organization[84]

There is now unambiguous evidence that breast milk accumulates and harbors potentially toxic environmental pollutants.[75,89,90,91] Persistent organohalogens, including **persistent organic pollutants (POPs), per- and polyfluoroalkyl substances (PFAS),**[92] heavy metals, and volatile solvents, are among the toxic chemicals most often found in breast milk. A woman comes in contact with environmental chemicals as a matter of course in daily life,[93] through air pollution, drinking water, and diet. A woman also comes in contact with a wide range of environmental chemicals in the home that have the potential to appear in her breast milk, such as household cleaning and personal care products, insect repellents, paints, furniture strippers, and pesticides. Exposure to environmental chemicals can also be occupational.

While the presence of low levels of environmental chemicals in most human milk samples is well documented, the significance of the presence of these contaminants on the well-being of the mother and the infant is unknown. Several studies[77,89–94] address concerns about potential impact on duration of lactation, neurodevelopmental and immunologic outcomes, and carcinogenic effects. While the body of research is growing, huge gaps in the current knowledge of any ill effects remain. In fact, other factors in breast milk may have a protective effect on normal neurologic development and immunologic outcomes.[74,80] At this time, there are no established "normal" or "abnormal" levels in breast milk for clinical interpretation, and breast milk is not routinely tested for environmental exposures.[80,91,94]

Unless the mother has a high level of occupational exposures, extreme dietary exposures (e.g., from fish in contaminated waters), or unusual residential exposures to hazardous or toxic chemicals, breastfeeding remains overwhelmingly the preferred choice compared with breast milk substitutes.[94-96] The WHO,[97] the AAP,[98] the CDC,[83] and other major health organizations overwhelmingly support the importance of breastfeeding even in a contaminated world. The benefits of breastfeeding, which include high levels of antioxidants, may prove to be essential to compensate for and outweigh the risk of toxic effects from the environment.

Women should be advised about how to reduce exposures that may affect breast milk quality rather than abandoning breastfeeding for artificial methods (Table 7.8).

persistent organic pollutants (POPs) A family of chemicals manufactured either for a specific purpose (e.g., pesticides or flame retardants in electrical equipment or furniture) or produced as byproducts of incinerated waste. The POP family includes dioxins, polychlorinated biphenyls (PCBs), polybrominated diphenyl ether (PBDE), and organochlorine pesticides.

per- and polyfluoroalkyl substances (PFAS) A family of man-made chemicals used in stain resistant fabrics, nonstick cookware, products that resist water, grease, oil, some cosmetics, and water-repellent clothing.

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Table 7.8 Steps a breastfeeding mother can take to reduce exposure to environmental chemicals

1. Avoid smoking cigarettes and drinking alcohol. Some studies have found levels of contaminants are higher in those who smoke and drink alcoholic beverages.
2. Be aware in purchasing homes that some houses or apartments, especially those built before 1978, might have lead-based paints.
3. In general, eat a variety of foods low in animal fats; remove skin and excess fat from meats and poultry. Avoiding high-fat dairy products may reduce the potential burden of fat-soluble contaminants. Avoid processed foods made from ground meat and animal parts such as sausage and hot dogs.
4. Increase consumption of grains, fruits, and vegetables. Thoroughly wash and peel fruits and vegetables to help eliminate the hazard of pesticide residues on the skin. When available, eat food grown without fertilizer or pesticide application. Eat organically grown food, if available.
5. Avoid fish that may have high mercury levels, such as swordfish, shark, tuna, king mackerel, tilefish, and locally caught fish from areas with fish advisories.
6. Limit exposure to chemicals such as solvents found in paints, non-water-based glues, furniture strippers, nail polish, and gasoline fumes.
7. If you work with solvents (in the workplace or at home), postpone breastfeeding for several hours after exposure.
8. Run tap water through a home filter before drinking. Filters can reduce levels of common tap water pollutants.
9. Remove the plastic cover of dry-cleaned clothing. Air out the garments in a room with open windows, or hang dry-cleaning outside for 12–24 hours.
10. Attempt to avoid occupational exposure to chemical contaminants in the workplace, and seek improved chemical safety standards for all employees, especially pregnant and lactating women. Workers should be diligent in following their workplace's safety recommendations.
11. Alert other family members to be sensitive to contaminant residue they may inadvertently bring into the home. It is possible, for example, to carry PCBs home on clothes, body, or tools. If this is the case, the individual should shower and change clothing before leaving work and keep and launder work clothes separate from other clothing.
12. Review additional suggestions for avoiding chemical exposures in and around the home from the report of the Environmental Working Group (refer to www.ewg.org/research/mothers-milk/study-findings).

Source: Condon, M. Breast is best, but it could be better: What is in breast milk that should not be? *Pediatr Nurs.* 2005; 31:333–338.

Women should avoid fish such as swordfish and shark or freshwater fish from waters reported as contaminated by local health agencies and limit exposure to chemicals such as pesticides and solvents found in paints, non-water-based glues, furniture strippers, nail polish, and gas fumes.

7.5 Neonatal Jaundice and Kernicterus

"The AAP discourages the interruption of breastfeeding in healthy term newborns and encourages continued and frequent breastfeeding (at least eight to twelve times every 24 hours)."

—American Academy of Pediatrics[99]

Neonatal jaundice is a yellow discoloring of the skin caused by too much bilirubin in the blood (**hyperbilirubinemia**). It is a common and usually benign condition that resolves on its own or with minimal intervention. At least 40 percent of healthy full-term[100] and 80 percent of preterm infants will become visibly jaundiced[101] with their serum bilirubin levels exceeding 5–7 mg/dL (85–199 µmol/L).[102] If hyperbilirubinemia does not resolve and becomes sufficiently severe, the elevated bilirubin levels can cause permanent neurological damage.[100–105]

hyperbilirubinemia Elevated blood levels of bilirubin, a yellow pigment that is a by-product of the breakdown of fetal hemoglobin.

In recent years, the overall incidence of infant jaundice has risen,[104] and hyperbilirubinemia is the most frequent cause for hospital readmission during the first two weeks of life in the United States.[106] More infants are becoming jaundiced, and their jaundice is more severe. The Joint Commission on Accreditation of Health-care Organizations (JCAHO), the CDC, and the AAP[99] have all noted the increasing rates and the need for prevention, early detection, and prompt treatment. Risk factors for the development of severe hyperbilirubinemia have been identified (Table 7.9). Higher rates of breastfeeding in conjunction with shorter postpartum hospital stays is the leading explanation for the higher prevalence of neonatal jaundice.[103,107]

It is important for all health professionals to understand the causes of, risk factors for, and early signs of hyperbilirubinemia. Preventing toxicity from excessive jaundice and protecting and ensuring successful breastfeeding require an understanding of the normal and abnormal patterns and mechanisms of jaundice in the newborn period, particularly the mechanisms related to human milk intake.[108]

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Table 7.9 Severe hyperbilirubinemia risk factors[100]

Maternal
Diabetes
Rh sensitization
Previous child with phototherapy
Race–East Asian or Mediterranean
Infant
Premature or late-preterm
High total serum bilirubin (TSB) levels at discharge
Poor breastfeeding in exclusive breastfed infant
Blood group incompatibility, e.g., ABO
Hemolytic disease, e.g., Gluocose-6-phosphate dehydrogenase deficiency (G6PD)

Sources: AAP/Pediatrics, ABM Protocol #22, and CDC.

Bilirubin Metabolism

Bilirubin is a byproduct of the normal physiologic degradation of hemoglobin. Most hemoglobin in the neonate is derived from fetal erythrocytes. Since higher levels of hemoglobin are necessary *in utero* to carry the oxygen delivered to the fetus by the placenta, the normal full-term infant has a hematocrit of 50–60 percent. As soon as the infant is born and begins to breathe room air, the need for high levels of hemoglobin is gone, and excess erythrocytes are destroyed. The released hemoglobin is broken down by the reticuloendothelial system; bilirubin, an insoluble byproduct of the breakdown of hemoglobin, is released into the circulation bound to albumin or another transport protein. The insoluble form of bilirubin is removed from circulation by the liver, which conjugates bilirubin to a water-soluble form and excretes it via the bile to the stool. The balance between liver cell uptake of bilirubin, the rate of bilirubin production, and the rate of bilirubin reabsorption through the intestines determines the total serum bilirubin (TSB) level.

Before birth, the maternal liver is responsible for metabolism and clearance of fetal bilirubin. After birth, unique developmental factors that control the production, conjugation, and excretion of bilirubin predispose the neonate to hyperbilirubinemia:[103,109,110]

- Bilirubin production in the neonate is double that of an adult because of breakdown of fetal erythrocytes.
- Uptake of insoluble bilirubin by the liver is limited because of a reduction in the concentration of ligandin, a bilirubin-binding protein in the liver cell.
- Conjugation to a water-soluble form is limited in the liver because of deficient activity of uridine diphosphoglucuronosyl transferase (UDPGT), a liver enzyme responsible for bilirubin conjugation.
- Excretion of bilirubin is delayed because of an enzyme present in the intestine of the newborn, beta glucuronidase, which converts conjugated bilirubin back into its unconjugated state, which is reabsorbed.

Physiologic Versus Pathologic Newborn Jaundice

After the first 24 hours, rising bilirubin levels in healthy term infants are reflective of the physiological breakdown of fetal hemoglobin, the increased resorption of the bilirubin from the intestines, and the limited ability of the newborn's immature liver to process large amounts of bilirubin as effectively as a mature liver. Neonates tend to produce more bilirubin than they can eliminate. Prematurity magnifies this imbalance. Retention of unconjugated bilirubin by the newborn is known as normal newborn jaundice or physiologic jaundice of the newborn.[108] Excessive bilirubin is deposited in various tissues, including the skin, muscles, and mucous membranes of the body, causing the skin to take on a yellowish color. In healthy newborns, this condition is temporary and usually resolves within a few days without treatment. In the typical newborn population, bilirubin levels rise steadily in the first 3–4 days of life and peak around the fifth day of life, and then decline. Bilirubin levels of healthy preterm infants peak later (day 6 to day 7) and take longer to resolve. Bilirubin levels in physiologic jaundice are usually less than 12 mg of bilirubin per dL of blood of infants of White or Black mothers, and average 10 to 14 mg in infants of Asian ancestry, including Chinese, Japanese, and Korean, and Native Americans.[111] Levels in White and Black mothers also peak earlier than in Asian or Native American mothers.[112]

In contrast to physiologic jaundice of the newborn, pathologic jaundice begins earlier (sometime it is observed before 24 hours of age), rises faster, and lasts longer. A TSB greater than 8 mg/dL in the first 24 hours should be investigated for pathologic origin. Causes of pathologic jaundice include the following:[102]

- Hemolytic disease (immune disorders, Rh isoimmunization, ABO, or minor blood type incompatibility)
- Erythrocyte disorders (glucose-6-phosphate-dehydrogenase deficiency, hereditary spherocytosis)
- Extravasation of blood (cephalohematoma, subgaleal hemorrhage, bruising)
- Inborn errors of metabolism/conjugation defects (galactosemia, Crigler–Najjar syndrome types I and II, Gilbert syndrome, Lucey–Driscoll syndrome)
- Hypothyroidism
- Polycythemia
- Macrosomic infant of diabetic mother
- Intestinal obstruction; delayed passage of meconium
- Sepsis

In most cases of pathological jaundice, frequent breastfeeding (8–12 times every 24 hours) can continue during diagnosis and treatment of pathological jaundice.[100,107] An advantage of colostrum and mature human milk is stimulation of bowel movements, speeding elimination of bilirubin. However, in jaundice caused by galactosemia, breastfeeding is contraindicated.[19,26]

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Since bilirubin is a cell toxin, concern arises when TSB elevates to levels with the potential to cause permanent damage. The brain and brain cells, if destroyed by bilirubin deposits, do not regenerate.[103] **Bilirubin encephalopathy**, or **kernicterus**, has a mortality rate of 50 percent, and survivors usually are burdened with severe problems including cerebral palsy, hearing loss, paralysis of upward gaze, intellectual, and other handicaps.[93] While full-scale kernicterus is rare, there has been an increase in reported cases in the last two decades.[103,107,106] There is also concern that mild effects of bilirubin on the brain may be manifested clinically in later life with symptoms such as incoordination, excessive contractions of muscles (hypertonicity), and intellectual deficits, or perhaps learning disabilities.[26,104,106]

Hyperbilirubinemia and Breastfeeding

Jaundice in the breastfed infant has been divided into types, early or late, based on the age of onset (Table 7.10). It is important to differentiate between the two to establish effective prevention and treatment. Early onset of elevated unconjugated bilirubin unexplained by other pathologic factors is associated with inadequate feeding and is called *breastfeeding jaundice* or, more precisely, *breast-nonfeeding jaundice*.[108] Late-onset (after day 5) prolonged elevation of unconjugated bilirubin associated with the ingestion of breast milk is called breast milk jaundice.[108,113]

bilirubin encephalopathy or kernicterus The chronic and permanent clinical sequelae that are the end result of very high untreated bilirubin levels. Excessive bilirubin in the system is deposited in the brain, causing toxicity to the basal ganglia and various brainstem nuclei.[100]

Breast-Nonfeeding Jaundice

The optimally breastfed infant initiates breastfeeding in the first hours, followed by at least 8–12 breastfeeds per day for the first 1–2 weeks without any water or other food supplementation, and with good positioning that assures effective milk transfer to the infant, and weight loss of less than 8 percent of birthweight.[106,107] Differences in bilirubin levels between adequately breastfed infants and formula-fed infants have not been found to be significant.[108] In contrast, infants who nurse infrequently or inefficiently ingest fewer calories and lose more weight than formula-fed infants are at risk for elevated bilirubin levels.[96] Suboptimal breastfeeding can delay passage of meconium and reduce fecal weight, increasing the hepatic circulation of bilirubin. In addition, reduced milk intake produces a state of partial starvation in the infant, which further increases the intestinal absorption of bilirubin.[106] Delay in initiation of breastfeeding beyond the first hour of life and administration of water to infants either before initiation of breastfeeding or in addition to breastfeeding significantly reduce the frequency of breastfeeding and increase bilirubin concentrations. Excessive hyperbilirubinemia causes lethargy and poor feeding in some infants, further reducing breastfeeding frequency and duration and milk production, feeding a vicious cycle of increasing bilirubin levels.

It is now well established that early-onset breastfeeding jaundice results from reduced volume of milk transfer to the infant, limiting caloric intake and producing a state of partial starvation and weight loss equivalent of the adult disorder known as starvation jaundice.[100] Lawrence and

Table 7.10 Comparison of breast-nonfeeding jaundice and breastmilk jaundice associated with hyperbilirubinemia while breastfeeding

	Breast-Nonfeeding Jaundice	Breastmilk Jaundice
Peak	Peaks 2–5 days of age	Peaks second and third week of age
Resolves	1–2 weeks after birth	Progressively declines 3–12 weeks after birth
Incidence	More common with first child; approximately 60% of U.S. newborns become clinically jaundiced	All children of a given mother
		Approximately 50% of breastfed infants may have mild to moderate jaundice
Feeding	Infrequent feeds, poor milk transfer	Adequate feeding frequency (8–12 times/24 hours, good milk transfer, no supplements
	Receiving water or dextrose water	
Supply	Low milk supply	Good milk supply
Stools	Stools delayed and inadequate	Normal stooling
Treatment	None or phototherapy, rarely exchange transfusion	None or phototherapy
		Temporarily discontinue breastfeeding
Associations	Low Apgar scores, water or dextrose water supplement, late-preterm, and prematurity	Previous sibling requiring phototherapy

Source: Adapted from *Breastfeeding: A Guide for the Medical Profession*, 9th ed., by R. A. Lawrence and R. M. Lawrence, Table 14.6, 2021.

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Lawrence outline treatment guidelines (Table 7.11) aimed at treating the actual cause—that is, failed breastfeeding or inadequate stooling or underfeeding.[25] The goal is to evaluate the breastfeeding for frequency, length of suckling, and apparent supply of milk, and then adjust the breastfeeding to solve the problem.[114] If stooling is an issue, the infant should be stimulated to stool. If starvation is the problem, the infant should receive temporary supplemental feeding by cup or bottle while the milk supply is being increased by better breastfeeding techniques.

Early discharge of infants from the hospital at less than 72 hours of life has raised concerns about the ability to evaluate breastfeeding and the opportunity to evaluate infants for jaundice.[99,103,107,110] Formal observation of breastfeeding with evaluation of effectiveness of breastfeeding and milk transfer at regular intervals throughout the first days of life can identify breastfeeding problems sufficiently early to ensure correction of problems. Nilsson et al. reported a decrease in readmissions at 1 week postnatal for interventions including jaundice following implementation of a parental breastfeeding programme for early discharges. The program focused on frequent breastfeeding, good positioning, increased skin-to-skin contact, and enhanced father involvement.[115] The AAP strongly recommends that all breastfed infants be evaluated by a trained observer within 2–3 days after discharge from the hospital.[99] Particular attention must be paid to infants who are less than 38 weeks' gestation and infants at moderate or high risk for severe hyperbilirubinemia (Table 7.10).[99,110]

Table 7.11 Prevention and management of early jaundice while breastfeeding infant, 35 weeks' gestation

1. Initiate breastfeeding early, preferably within the first hour after birth. Nurse infant 8–12 times per day for the first several days.
2. Monitor stooling pattern, wet diapers, and baby weight.
3. Optimize breastfeeding management from the beginning.
4. Exclusive breastfeeding is recommended. Avoid supplementation with glucose water, water, or formula supplements. This delays the establishment of breastfeeding and may increase risk of breastfeeding-nonfeeding jaundice. Supplements including expressed breast milk should be limited and used only in the presence of inadequate intake with weight loss, inadequate milk transfer, inadequate milk production, and dehydration.
5. Provide adequate breastfeeding support and educate mother on feeding cues and to respond to early feeding cues. Crying is a late hunger cue that may contribute to poor breastfeeding.
6. Identify at-risk mothers and babies prior to discharge.
7. Breastfeeding should be continued and encouraged during phototherapy.
8. If temporary interruption of breastfeeding is needed, mother should protect milk production with electric pump.

Source: Based on Subcommittee on Hyperbilirubinemia, "Management of Hyperbilirubinemia in the Newborn Infant 35 or More Weeks of Gestation," *Pediatrics*, 2004; 114(1):297–316.

Breast Milk Jaundice Syndrome In contrast to physiological newborn jaundice, which peaks around day 5 and then begins to drop, breast milk jaundice syndrome becomes apparent after the third day, and bilirubin levels may peak any time from the seventh to the tenth day, with untreated cases being reported to peak as late as the fifteenth day.[26] In breast milk jaundice syndrome, no correlation exists with weight loss or gain, and stools are normal. Initially, breast milk jaundice syndrome was thought to be an unusual and distinct type of newborn jaundice affecting 1 percent of all breastfed neonates. More recent research reports demonstrated that at least one-third of all breastfed infants are clinically jaundiced in the third week of life and that two-thirds have significant unconjugated hyperbilirubinemia in the third week, in contrast to the absence of hyperbilirubinemia in the third week in full-term artificially fed infants.[18,103] What was once believed to be a clinical disorder is now recognized as a normally occurring extension of physiologic jaundice of the newborn.[112,113] However, at this time, there is insufficient evidence to support the popular theory that breast milk jaundice may provide protective effects for newborns by the antioxidant effects of bilirubin, compensating for the relative deficiency of endogenous antioxidants in newborns.[108]

The cause of breast milk jaundice syndrome is believed to be a combination of factors: a substance in most mothers' milk that increases intestinal absorption of bilirubin and individual variations in the infant's ability to process bilirubin.[19,26,108] To treat severe elevations in unconjugated bilirubin in breast milk jaundice syndrome, the AAP Clinical Practice Guidelines for Hyperbilirubinemia[100] are applied with the goal of promptly lowering TSB bilirubin levels substantially to limits set for the infant's age and level of risk. To establish the diagnosis of breast milk jaundice firmly when the bilirubin level is above 16 mg/dL for more than 24 hours, a short, temporary interruption of breastfeeding (12–24 hours) while monitoring bilirubin levels is recommended.[26,108]

The belief that severe hyperbilirubinemia in breastfed infants cannot result in kernicterus is erroneous and dangerous; 98 percent of the 105 cases of kernicterus in the U.S. Kernicterus Registry were breastfed infants.[114] Kernicterus, while rare, can develop in otherwise healthy full-term breastfed newborns or breastfed infants with sepsis. Breastfed infants need to be followed closely, supported effectively, and evaluated appropriately in order to avoid rare cases of severe hyperbilirubinemia and kernicterus.[99]

Interrelationships between Breast-Nonfeeding Jaundice and Breast Milk Jaundice Syndrome While breast-nonfeeding jaundice and breast milk jaundice are two separate entities, they can have an interactive effect on each other. Infants with breast milk jaundice who manifest higher levels of bilirubin in the second and third weeks of life, often over 15 mg/dL, have been noted to have had relatively high serum bilirubin concentrations during the first

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3–5 days of life due to breast-nonfeeding jaundice, hemolysis, or unknown etiology.[113] Gartner postulates that these early, elevated bilirubin levels may produce an enlarged bilirubin pool. Then the ingestion of mature milk and a consequent enhancement of the enterohepatic circulation may enlarge the pool even further.[113]

Prevention and Treatment for Severe Jaundice

The AAP guidelines for the management of hyperbilirubinemia in healthy term newborns include a detailed algorithm for the management of jaundice in the newborn nursery and guidelines for initiating phototherapy.[99] Phototherapy involves placing the newborn under special fluorescent lights that, like sunlight, assist in removing jaundice from the skin. The light is absorbed by the bilirubin, changing it to a water-soluble product, which can then be eliminated without having to be conjugated by the liver.

Historically, treatment for jaundice in American hospitals involved phototherapy and discontinuing breastfeeding either permanently or until the bilirubin levels were acceptable. In addition, many health professionals believed that newborn infants would become dehydrated if they were not supplemented with water or formula during the first days of breastfeeding. Recent research shows these practices are counterproductive.[100,108] The benefits of early and frequent breastfeeding in the first days of life for prevention of hyperbilirubinemia through maintaining hydration and stimulating the passage of stool are now well documented. The passage of stool in the newborn is important because there are 450 mg of bilirubin in the intestinal tract **meconium** of the average newborn.[26] To avoid reabsorption of bilirubin from the gut into the serum, passing meconium in the stool is critical. The current AAP hyperbilirubinemia management guidelines encourage continued and frequent breastfeeding (at least 8–12 feedings every 24 hours) in healthy term newborns, and recommends against routine supplementation of nondehydrated breastfed infants with water or dextrose water, as this practice will not prevent hyperbilirubinemia or decrease total serum bilirubin levels.[100]

Information for Parents

Health-care professionals should convey a balanced approach when communicating with parents about jaundice. Parents need to know that most breastfed infants will become jaundiced and that the overwhelming majority of cases will be benign. Only a small fraction of these infants is at risk for developing extreme hyperbilirubinemia and kernicterus. However, parents also need to fully understand the serious consequences of extremely elevated bilirubin levels and should have their infant evaluated by a health professional if jaundice develops. Health-care professionals need to understand that feelings of guilt are common among mothers of jaundiced infants as many mothers feel that they caused the jaundice by breastfeeding.[116] By providing accurate information and encouragement to breastfeed, health-care professionals have a great impact on whether a mother continues breastfeeding after her experience with neonatal jaundice.

meconium Dark green mucilaginous material in the intestine of the full-term fetus.

7.6 Breastfeeding Multiples

Since 1980, the birthrate of twins has increased by 70 percent, and the birthrate of higher-order multiples (triplets and more) increased by over 400 percent from 1980–1998. According to the National Vital Statistics Report published in 2022, rates of twin births declined in 2020 from their peak in 2014 and rates of multiple births also declined from their peak in 1998.[117,118] In the United States, multiples currently represent over 3 percent of live births. The benefits of breastfeeding to mother and infant are multiplied with twins and higher-order multiples, who often are born at risk.[119] History and numerous case reports[120–122] provide ample evidence that an individual mother can provide adequate nourishment for more than one infant. In seventeenth-century France, wet nurses in foundling homes fed three to six infants, who were often of differing ages with different daily requirements.[26,123] Breastfeeding initiation rates of nearly 70 percent have been reported by surveys of members of Mothers of Super Twins (MOST); Parents of Multiple Births Association (POMBA) of Canada; and *Double Talk*, a newsletter for parents of multiples. Some mothers of triplets and quadruplets have fully breastfed their babies.[19,121]

Frequency and effectiveness of breastfeeding are the keys to building a plentiful milk supply. The more often a baby nurses, the more milk there will be.[26,118] Mothers who exclusively breastfeed twins or triplets can produce 2–3 L/day, although this involves nursing an average of 15 or more times per day.[124] The main obstacle to nursing multiples is not usually the milk supply, but time and fatigue of the mother. Parents of twins and higher-order multiples need support in four major areas: organization, feeding, individualized time for each baby, and stress management.[118] The COVID-19 pandemic created barriers to obtain support for breastfeeding mothers as they faced isolation and lack of in-person support. The various support impacted included informational, instrumental, and emotional all of which are crucial for breastfeeding success for parents of multiples.[125]

Mothers of twins or higher-order multiples often face special challenges in the establishment of lactation after birth.[126] Approximately 60 percent of twins and 90 percent of higher-order multiples in the United States are born at less than 37 weeks' gestation, and premature multiples often experience medical complications that potentially

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interfere with breastfeeding.[127] Breastfeeding initiation may take place in the neonatal intensive care unit, usually because of prematurity and low birthweight. Mothers of multiples may be coping with the effects of a more physically demanding pregnancy and birth or complications of pregnancy. Mothers may experience exaggerated postpartum sleep deprivation related to round-the-clock care of two or more newborns, concern for sick newborns, or staggered infant discharge, which results in time divided between infants at home and in the hospital. In addition, every aspect of breastfeeding management is affected by the dynamics that multiple newborns create.[26,119] In a study by Geraghty et al., breastfeeding initiation rates as high as 73 percent were found among full-term multiples compared with initiation rates of only 57 percent in preterm multiples. Breastfeeding duration was also lower in preterm multiples than in term multiples (12 weeks versus 24 weeks).[19,127] Porta et al. reported breastfeeding disparities between singletons and multiples from a NICU. The authors documented exclusive breastfeeding in 31 percent of singletons and a combination of both breastfeeding and bottle-feeding in 26 percent. Multiples discharged from the same NICU were reported as exclusive breastfeeding in 24 percent and a combination of both breastfeeding and bottle-feeding in 33 percent. Multiple births, including twins, were associated with a small statistically significant effect on cessation of breastfeeding before discharge.[128]

Health-care professionals can help the mothers of multiples face the many challenges of breastfeeding by offering consistent, informed, individualized care, education, and support in the hospital and after discharge.[124] Knowledgeable care providers can help parents distinguish among multiples-specific issues, normal variations in an individual infant's breastfeeding abilities and patterns, and actual breastfeeding problems. Mothers need information on when and how to initiate simultaneous feedings, practical tips for managing night-time nursing and fatigue, and how to evaluate whether their babies are getting ample nourishment.[119] Parents need to be informed of resources for parenting multiples and for receiving support for breastfeeding in their community. The COVID-19 pandemic has negatively impacted community support. A well-defined plan for the health-care of the lactating woman that includes screening for nutritional problems and providing dietary guidance is also important.[69] Mothers should be encouraged to drink to satisfy their thirst, to eat nutritious foods, and to sleep when the babies sleep. As in singleton nursing, women nursing multiples should be encouraged to obtain their nutrients from a well-balanced, varied diet rather than from vitamin/mineral supplements.

7.7 Infant Allergies

Protection from **allergic diseases** is one of the most important benefits of breastfeeding. There are numerous studies in this area being done at the present time. Many studies have shown exclusive breastfeeding for at least 3 to 4 months can protect against atopic dermatitis and wheezing illnesses in children for the first 2 years of life with longer breastfeeding duration protecting beyond 5 years of age.[23,129-131] Other studies have shown no effect on allergy.[23] Elimination of major food allergens from the diet of breastfeeding mothers of infants at high risk for atopic disease was previously recommended to delay or prevent some food allergies and atopic dermatitis. However, recent expert reviews continue to conclude that there is no strong evidence to support this recommendation.[129,131–134] Studies continue on the role of maternal diet restrictions while breastfeeding high-risk infants. The National Institute of Allergy and Infectious Diseases released guidelines in 2010 for diagnosing and managing food allergies. They discussed inadequacies in many of the published literature and studies. They do not recommend avoidance of food allergens during lactation. The committee encouraged exclusive breastfeeding for at least 4 months and supports exclusive breastfeeding recommendations for 6 months.[26,132–134] A recent well-controlled study confirmed that the presence of food proteins in human milk is common, but this can be highly variable among women consuming the same challenge (dose) food.[132] A number of other studies measuring proteins in human milk following challenge doses of eggs, cow's milk, gluten, and wheat protein also found variable response among women.[130–132]

Food Allergy (Hypersensitivity)

A **food allergy,** or **hypersensitivity,** is an abnormal or exaggerated immunologic response, usually immunoglobulin E (IgE) mediated, to a specific food protein. The development of infant food allergies is influenced by genetic risk for allergy, duration of breastfeeding, time for introduction of other foods, maternal cigarette smoking during pregnancy and parental smoking, air pollution, exposure to infectious disease, and maternal diet and immune systems.[130] Several mechanisms (Table 7.12) are thought to contribute to the protective effect of breastfeeding.

Common pediatric food allergens include:

- Cow's milk
- Wheat
- Eggs
- Peanuts
- Soybeans
- Tree nuts (e.g., almonds, Brazil nuts, walnuts, hazelnuts)

allergic diseases Conditions resulting from hypersensitivity to a physical or chemical agent.

food allergy (hypersensitivity) Abnormal or exaggerated immunologic response, usually immunoglobulin E (IgE) mediated, to a specific food protein.

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Table 7.12 Possible reasons for allergy-preventive effects of breastfeeding[121,122]

• Low content of allergens
• Transfer of maternal immunity
• Long-chain fatty acids and IGA in breast milk protect against inflammation and infections
• Regulation of infant immunity
• Influence on gut microbial flora

Infants with a positive family history of allergies should be exclusively breastfed for at least 4–6 months with continuance of breastfeeding for as long as possible.[26,34,130]

Food Intolerance

Although infants may have sensitivities to certain foods, there is no scientific basis for the concern about gassy foods, such as cabbage or legumes, causing gas in the breastfed baby. In mothers, the normal intestinal flora produces gas from the action on fiber in the intestinal tract. Neither the fiber nor the gas is absorbed from the intestinal tract, and neither enters the mother's milk. Likewise, the acid content of the maternal diet does not affect the breast milk because it does not change the pH of the maternal plasma.

It is common for the mother who is breastfeeding her child with colic to believe her child's symptoms are caused by a **food intolerance**. However, the role of diet in infantile colic, which affects 10 to 40 percent of infants and up to 28 percent of infants in the first months of life[135,136] is controversial. While breastfeeding is not protective against infantile colic, several studies report a reduction in persistent crying after elimination of cow's milk and other food proteins from the maternal diet. In a randomized, controlled trial, a low-allergen maternal diet was associated with a reduction in distressed behavior among breastfed infants with colic.[136] The mothers excluded cow's milk, eggs, peanuts, tree nuts, wheat, soy, and fish from their diet. A maternal low-allergen diet has been further studied in a systematic review that supported the low-allergen diet as an option to reduce colic. *Lactobacillus reuteri,* a probiotic, has been reported to reduce colic symptoms in four out of five clinical trials with no reported adverse effects and may be an option for the breastfeeding mother who is unable to follow the low-allergen diet.[135]

Characteristic essential oils in foods such as garlic and spices may pass into the milk, and an occasional infant objects to their presence. Studies by Mennella and Beauchamp confirm that the diet of lactating women alters the sensory qualities of her milk.[137,138] Extensive clinical experience also suggests that some infants are sensitive to certain foods in the mother's diet. According to Lawrence and Lawrence, garlic, onions, cabbage, turnips, broccoli, beans, rhubarb, apricots, or prunes may be bothersome to some infants, making them colicky for 24 hours.[12] In the summer, a heavy diet of melon, peaches, and other fresh fruits may cause colic and diarrhea in the infant. Red pepper has been reported to cause dermatitis in the breastfed infant within an hour of milk ingestion.[139] Contrary to popular belief, chocolate rarely causes problems and can be consumed in moderation without causing colic, diarrhea, or constipation in most infants.[24]

If a mother suspects that her baby reacts to a specific food, it may be helpful for her to keep a record of foods eaten, along with notes on the baby's symptoms or behavior. If highly allergic or sensitive, infants may react to foods their mothers have eaten within minutes, although symptoms generally show up between 4 and 24 hours after exposure. While symptoms will improve in most infants after the offending food has been removed from the mother's diet for 5–7 days, it may take 2 weeks to totally eliminate all traces of the offending substance from both the mother and baby[140] (Case Study 7.2).

food intolerance An adverse reaction involving digestion or metabolism but not the immune system.

7.8 Late-Preterm Infants

Infants born between 34 and 37 weeks are considered late-preterm. They account for as high as 75 percent of all preterm singleton births.[141] These infants too often are treated as full term; they often have subtle immaturity that makes establishing breastfeeding difficult and places the infant at risk for insufficient milk intake, hypoglycemia, jaundice, and poor weight gain.[4,23,142] Late-preterm infants have two to three times higher rates of hospital readmission during the neonatal period compared to term infants.[9,142-144] Infants may have cardiorespiratory instability, especially in upright position, poor temperature control, lower glycogen and fat stores to prevent hypoglycemia, and an immature immune system. In addition, the suck–swallow coordination may be poorly coordinated and result in poor latch-on and milk transfer. According to the Academy of Breastfeeding Medicine, some early-term infants, those born between 37 and 38 weeks, may also be at higher risks of hospital readmission, jaundice, and breastfeeding when compared to term infants.[144]

The main emphasis in postpartum care should be on building and maintaining the milk supply and feeding the infant. Skin-to-skin contact should be encouraged immediately after birth as medically able. Milk production relies on adequate suckling stimulation. Late- preterm and early-term infants may not be able to stimulate the breast enough to produce an adequate milk supply.[142] These infants often struggle with stamina and maintaining an alert state.[144] If an infant is not sucking vigorously

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Case Study 7.2 Breastfeeding Premature Infants

Thirty-five-year-old Sam delivers twin boys at 30 weeks' gestation: baby Tyler is 2 lb, 9 oz, and 13.5 in.; baby Charlie is 1 lb, 13 oz, and 14 in. long. Sam had a difficult pregnancy that included severe nausea and vomiting, heartburn, preeclampsia, and preterm labor.

Sam is very committed to breastfeeding and was able to use a hospital-grade electronic breast pump approximately six hours after delivery. She pumps every 2–3 hours or eight to nine times daily in order to establish her milk supply. At the end of the first week, Sam is pumping about 14–16 oz/day per baby, and by 3½ weeks she is pumping 4–5 oz per breast at each pumping. Sam wakes at night to pump when she is full. She has placed the pumping equipment by the bed and become adept at pumping, getting out of bed only to put the milk in the refrigerator. At 2 weeks' postpartum, Sam experiences ductal narrowing due to inflammation and has difficulty emptying the right breast for 2 days.

The twins have suffered the usual preterm difficulties with breathing, apnea, and bradycardia. Initially the twins are tube-fed. As their condition improves, baby Tyler is first put to breast 3 weeks after his birth, and baby Charlie several weeks later. Baby Charlie has more difficulty learning to latch on and suck and is growing more slowly than Tyler. Multiple interventions are used to achieve breastfeeding success. On advice from a lactation consultant, Sam uses a nipple shield to help baby Charlie latch on. In response to slow weight gain in baby Charlie, the lactation consultant recommends that the baby receive hindmilk, which is often higher in fat and calories.

Charlie and Tyler are released from the hospital a day after their due date. Sam continues using the nipple shield for several weeks with Charlie, trying without the nipple shield every few days. After 3 weeks at home, baby Charlie is able to latch on without the nipple shield. The twins are breastfed and also receive up to three bottles of fortified expressed breast milk or premature infant formula per day for the first 2 months at home. The babies take feedings equally well from bottle or breast.

Questions

1. How often should the mother be pumping to establish and maintain a full milk supply?
2. List at least two possible nutrition diagnoses for this case.
3. Identify at least one nutrition intervention for each diagnosis listed.
4. List potential indications for each intervention listed.

(Answers are located in the Instructor's Manual for the 8th edition of *Nutrition Through the Life Cycle*.)



Mike Goldwater/Christian Aid/Alamy Stock Photo

or the suckling ability is weak, mothers of late-preterm infants should pump after each feeding attempt, or at least every three hours, to build the milk supply. In some cases where the infant has a weak suck and is unable to meet nutritional and fluid needs from oral feedings, a nasogastric or orogastric feeding tube may temporarily be used. A specific feeding plan, including the plan to wake a sleepy infant every 2–4 hours, is recommended to avoid the late-preterm breastfeeding cascade (Figure 7.1). Mothers and their late-preterm and early-term infants should have a feeding assessment by a trained lactation professional who can provide intervention for positioning, potential suck problems, and other breastfeeding issues. Weighing an infant before and after feedings may be useful to determine milk transfer. Discharge planning should include follow-up care, home visits, and lactation counseling as needed. Close follow-up should be continued until the infant is gaining weight and the mother is comfortable.[142,144]

7.9 Human Milk and Preterm Infants

> "The potent benefits of human milk are such that all preterm infants should receive human milk. Mother's own milk, fresh or frozen, should be the primary diet, and it should be fortified appropriately for the infant born weighing less than 1.5 kg."
>
> —American Academy of Pediatrics[56]

The benefits of breastfeeding may be most visible among preterm infants who are born immature and without adequate stores of nutrients. The nutritional benefits include ease of protein digestion, fat absorption, and improved lactose digestion.[144–147] The known health and developmental benefits include better visual acuity, greater motor and mental development at 1.5 years of age, greater verbal intelligence quotient at 7–8 years of age, and a lower incidence

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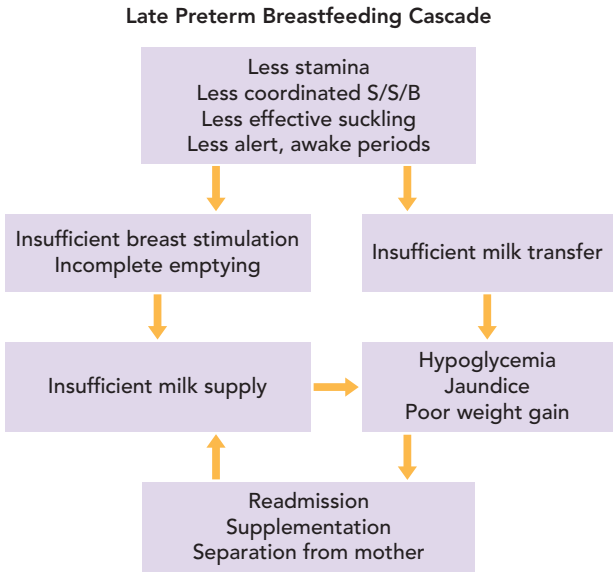


Figure 7.1 Later preterm infant breastfeeding cascade.

Source: Adapted from Wight, N. E. Breastfeeding the borderline (near-term) preterm infant. *Pediatric Annals*, 2003; 32(5):329–336.

of serious infectious disease, including necrotizing enterocolitis and sepsis, even among infants who also receive some human milk substitutes.[146–148] Nosocomial infection rates may also be decreased by as much as 50 percent in premature infants who receive at least 50 percent of their daily feedings from mother's milk.[148]

The composition of milk from women who deliver preterm infants is higher in protein, slightly lower in lactose, and higher in energy content (58–70 kcal/100 mL) compared to the milk of women who deliver full-term infants (approximately 62 kcal/100 mL). Once growth is established, the nutritional needs of the preterm infant exceed the content of human milk for protein; calcium; phosphorus; magnesium; sodium; copper; zinc; riboflavin; pyridoxine; folic acid; and vitamins C, D, E, and K.[34] Lower weight and length gains and poorer bone mineralization have been reported in preterm infants fed human milk without fortification.[149] Human milk fortifiers are available that provide additional protein, minerals, and vitamins.[34] Infants who receive fortified human milk do not need additional supplementation unless a specific nutritional problem is identified. The health benefits, particularly reduction in sepsis and necrotizing enterocolitis, outweigh the slightly lower rate of weight gain and length gain observed among preterm infants fed fortified human milk compared to those who receive a human milk substitute for premature infants.[149]

Early feeding seems to be important for preterm infants (when medically appropriate). Early feeding may be important to the ability to digest[145] and to the development of the infant's digestive system.[150] Often, milk must be expressed and stored for preterm infants. Establishing a milk supply is important to the mother's ability to maintain a milk supply that will meet her infant's demands after several weeks (refer to "Can Women Make Enough Milk?" in Chapter 6). A woman who is pumping less than 750 mL of milk by 2 weeks may need additional support to establish a milk supply that will meet her infant's needs beyond the first month.

Despite the health benefits of feeding human milk to preterm infants, the incidence and duration of breastfeeding of preterm infants in the United States is about 30 percent lower than rates for full-term infants.[147] The challenges of feeding low-birthweight infants include provision of adequate calorie and nutrient intake, establishing and maintaining an adequate milk supply, and transitioning from gavage feeding to feeding from the breast.[147] Strategies to improve breastfeeding rates in this vulnerable population include providing the parents with information necessary to make an informed decision to breastfeed; assisting the mother with the establishment and maintenance of a milk supply; ensuring correct breast milk management (storage and handling) techniques; providing skin-to-skin (kangaroo) care and opportunities for nonnutritive sucking at the breast; managing the transition to the breast; measuring milk transfer; preparing the infant and family for discharge; and providing appropriate follow-up care.[151,152] A nipple shield may be useful to help the preterm infant maintain latch and breastfed easier. A nipple shield is a thin, soft silicone breastfeeding device that does not impact nipple stimulation. Counseling mothers of very low-birthweight infants on the benefits of breast milk and providing breastfeeding support increase breastfeeding initiation and breast milk feeding without increasing maternal anxiety and stress.[153]

In addition to improving breast milk supply, skin-to-skin contact provides protection to the premature infant in the neonatal intensive-care unit (NICU). The lactating mother produces specific antibodies in her milk against pathogens in the infant's environment through the entero-mammary system.[23]

7.10 Medical Contraindications to Breastfeeding

Few medical problems in the mother or baby are absolute contraindications to breastfeeding (Table 7.13). There are very few infectious pathogens that pose a risk to the newborn that outweighs the potential benefits of breastfeeding.[154] Even infants with metabolic disorders such as phenylketonuria can continue to breastfeed in combination with a specialized formula to meet calorie and protein needs. When mothers or infants have medical or other problems that cause a poor suck or other feeding problems, early identification and appropriate support from a lactation consultant are necessary for successful breastfeeding. In some cases, pumping milk may be necessary to

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Table 7.13 When should a mother avoid breastfeeding?

Health-care professionals agree that human milk provides the most complete form of nutrition for infants, including premature and sick newborns. However, there are rare exceptions when human milk is not recommended. Under certain circumstances, a physician will need to make a case-by-case assessment to determine whether a woman's environmental exposure or her own medical condition warrants her to interrupt or stop breastfeeding.

Breastfeeding is NOT advisable if one or more of the following conditions is true:

1. An infant diagnosed with galactosemia, a rare genetic metabolic disorder
2. The infant whose mother:
   - Has been infected with the human immunodeficiency virus (HIV)
   - Is taking antiretroviral medications
   - Has untreated, active tuberculosis
   - Is infected with human T-cell lymphotropic virus type I or type II
   - Is using or is dependent on an illicit drug
   - Is taking prescribed cancer chemotherapy agents, such as antimetabolites that interfere with DNA replication and cell division
   - Is undergoing radiation therapies; however, such nuclear medicine therapies require only a temporary interruption in breastfeeding

NOTE: For additional information, visit American Academy of Pediatrics' Breastfeeding and the Use of Human Milk, or read: American Academy of Pediatrics Committee on Drugs. The transfer of drugs and other chemicals into human milk. *Pediatrics*. 2001; 108:776–789. Available at http://pediatrics.aappublications .org/cgi/content/full/108/3/776.

Source: From www.cdc.gov/breastfeeding/diseases.

maintain a supply of milk while problems with the infant suck are addressed and corrected. Whenever a medical situation presents a potential risk for breastfeeding infants, the theoretical risk must be carefully measured against the projected benefits of breastfeeding.[155]

Breastfeeding and HIV Infection

The transmission of HIV type 1 from mother to child through breastfeeding is well documented. In 2021, 160,000 new world-wide cases of **HIV** were documented in children ages 0–14. This is a 51 percent decline from 2010 and shows the progress being made in mother-to-child transmission of HIV.[156] Reports of transmission rates range between 15 and 45 percent, with prolonged breastfeeding doubling the rate to 35–40 percent without antiviral therapy interventions and less than 5 percent transmission rates with effective antiviral therapy.[157,158] Factors contributing to these variable rates include strain of HIV, maternal illness, immune status and viral load, duration of breastfeeding (timing of transmission), primary infection of the mother during the breastfeeding period, exclusive breastfeeding versus mixed feeding, mastitis, maternal vitamin deficiencies (A, C, E, or B vitamins), and the availability of antiretroviral therapy.[155–160] UNICEF has a mother-to-child transmission reduction program that reports since the beginning of the program in 2011, 1.2 million child deaths and 2.5 million child HIV infections have been averted.[157]

In developed countries, where safe and affordable breast milk substitutes are available, Women living with HIV or aids should be counseled strongly not to breastfeed.[160] The U.S. Department of Health and Human Services' Blueprint for Action on Breastfeeding states that "HIV-infected women in the United States should not breastfeed or provide their breast milk for the nutrition of their own or other infants because of the risk of HIV transmission to the child" (p. 12).[96] This recommendation is also supported in the American Academy of Pediatrics Policy Statement on Use of Human Milk.[159]

The choice for women with HIV in developing countries differs. In most cases, breast milk substitutes are not affordable to families or to government-sponsored public health programs, and they pose a serious health risk to infants both with and without HIV.[156,160,161] In 2016, the WHO updated recommendations regarding breastfeeding and HIV. The revised guidelines now recommend all infants be exclusively breastfed for the first six months of life, at which time solid foods may be introduced. Breastfeeding is recommended for at least the first 12 months of life. It is common in many undeveloped countries for mothers to breastfeed their children for at least 24 months. In the new guidelines, the importance of antiretroviral therapy is stressed to reduce HIV transmission via breast milk. Replacement feeding is not recommended in the new guidelines unless it is "acceptable, feasible, affordable, sustainable and safe (AFASS)."[154]

Exclusive breastfeeding by the mother or lactating person living with HIV or AIDS has been shown to reduce risk of transmission in the early months when compared to partial breastfeeding or mixed feeding.[142] Authorities in each country should make recommendations regarding breastfeeding and antiretroviral therapy to prevent HIV transmission.[162]

Detailed instructions on counseling women and persons living with HIV or AIDS are available from WHO. All women should be encouraged to know their HIV status and seek early prenatal care. Women need to be aware of the risks of HIV transmission during pregnancy and lactation.

7.11 Human Milk Collection and Storage

"Human milk is the most appropriate food for infants, and is also used as medical therapy for older children and adults with certain medical conditions. Human milk has a long history and proven track record both as nutrition and therapy."

—Human Milk Banking Association of North America

The appropriate collection and storage of human milk is important whether the milk is for the mother's own infant or to be donated. All of the collection containers

HIV Human immunodeficiency virus.

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used should be cleaned by dishwasher or sterilized by boiling. Hand pumps, electric handheld pumps, hospital-grade electric breast pumps, and manual expression can be used to extract the milk. The American Academy of Breastfeeding Medicine has published evidence-based guidelines for the collection and storage of human milk for home and human milk banking.[162] The Academy of Nutrition and Dietetics has published under the Pediatric Nutrition Practice Group "Infant and Pediatric Feedings: Guidelines for Preparation of Human Milk and Formula in Health-Care Facilities" [163] and Human Milk Banking Association of North America has published "Best Practice for Expressing, Storing and Handling Human Milk in Hospitals, Homes and Child Care Settings."[164] Table 7.14 presents current recommendations for milk storage for home use.

How much volume should the mother be pumping? Volumes vary according to initiation and frequency of pumping. Prematurity and stress also impact production, as discussed earlier. The pumping frequency in the early days after delivery correlates to production goals. The mother who pumps 8–10 times per day on days 2 and 3 postdelivery is more likely to achieve production goals than the mother who doesn't initiate pumping until day 3 and only pumps 3–4 times per day. The mother should begin pumping 6 hours after delivery, if possible. Typical volumes to produce the first few days are 1–10 cc/pumping. By days 5–8, those volumes should increase to 1½–2½ oz/day, and by days 10–14, the mother should be producing 2½–4 oz/day. A full milk supply is considered 25–35 oz per day.[165–167]

Milk Banking

"All preterm infants should receive human milk. Pasteurized donor human milk appropriately fortified should be used if mother's own milk is unavailable or its use is contraindicated."

—American Academy of Pediatrics[159]

Human Milk Banking Association of North America (HMBANA) adheres to national guidelines for quality control of screening and testing of donors and pasteurize all milk before distribution. HMBANA member milk banks are nonprofit organizations. Fresh human milk from unscreened donors is not recommended because of the risk of transmission of infectious agents.

Human milk banks provide human milk to infants who cannot be breastfed by their mother. Premature and sick infants are most likely to receive banked milk. A woman can donate milk once or on a continuing basis if her supply exceeds the demands of her infant. There is a long history of providing human milk to infants by persons other than the biological mother.[168] Wet nurses were the main source of human milk until the early 1900s for infants not fed by their biological mothers. Milk banks began in Europe and followed in the United States. Some neonatal intensive care units had informal milk banks until the 1980s. As a result of the human immunodeficiency virus, the resurgence of tuberculosis, and risks related to donors who might abuse drugs, human milk banks are now scarce in North America, but because of recognition of the importance of human milk,

Table 7.14 Storage duration of fresh human milk for use with healthy full-term infants

Location	Temperature	Duration	Comments
Countertop, table	Room temperature (up to 77°F or 25°C)	4–8 hours	Containers should be covered and kept as cool as possible; covering the container with a cool towel may keep milk cooler. Shortest time frame of 4 hours is most optimal.
Insulated cooler bag	5°–39°F or −15°–24°C	24 hours	Keep ice packs in contact with milk containers at all times, limit opening cooler bag.
Refrigerator	39°F or 4°C	4–7 days	Store milk in the back of the main body of the refrigerator. Shortest time frame of 4 days is most optimal.
Freezer			
Freezer compartment of a refrigerator	5°F or −15°C	2 weeks	Store milk toward the back of the freezer, where temperature is most constant. Milk stored for longer durations in the ranges listed is safe, but some of the lipids in the milk undergo degradation, resulting in lower quality.
Freezer compartment of refrigerator with separate doors	0°F or −18°C	3–6 months	Shortest time frame of 3 months is most optimal.
Chest or upright deep freezer	−4°F or −20°C	6–12 months	Shortest time frame of 6 months is most optimal.

Source: Based on Academy of Breastfeeding Medicine. *Protocol Number #8: Human Milk Storage Information for Home Use for Healthy Full-Term Infants, Revised 2017*. Princeton Junction, NJ: Academy of Breastfeeding Medicine.

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demand is increasing. There are 31 HMBANA member banks currently open in the United States and Canada with three more in the development process of becoming a milk bank.[168] A network of milk banks meet and share information through the HMBANA. A copy of the association's guidelines for milk storage is available for a fee. Millions of ounces are distributed annually in North America.

Human milk donors are chosen by their health profile. Women are carefully screened before they can donate extra milk to milk banks. Milk banks that belong to the HMBANA require telephone screening, a written health and lifestyle history, and verification of the health of the mother and baby by the health-care provider of each. Blood samples are tested for hepatitis B, hepatitis C, HIV-1 and HIV-2 (AIDS), human T-cell leukemia-lymphoma virus (HTLV I and II), and syphilis by the milk bank.[168] Requirements vary, but women are not accepted as donors if they are acutely ill, have had a blood transfusion or an organ transplant within a year, drink more than 2 oz of liquor daily, regularly use medications or megavitamins, smoke, or use street drugs. Additionally, women who eat no animal products must take vitamin supplements with B_{12} to be eligible to donate.[168]

Human milk is carefully pasteurized to kill any potential pathogens while preserving the nutrients and active immune properties of the milk. The HMBANA communicates closely with the FDA to follow guidelines for use of human tissues and fluids. Human milk for milk banks is stored frozen to preserve the immunologic and nutritional components. Rigid plastic (polypropylene) containers are recommended for keeping the milk composition stable. White blood cells stick to glass, but not to plastic containers.[169]

A prescription from a physician or a hospital is needed to order milk for an infant from one of the HMBANA milk banks. Costs are approximately $4.00 for term donor milk per ounce before shipping charges and vary for pre-term, dairy free, and fat-free donor milk.[168] Some insurance companies and Medicaid programs cover the fees when it is demonstrated that donor milk is the most appropriate therapy for a specific patient. Many milk banks in the United States offer donor milk at reduced costs. Mothers should be instructed to contact their local milk bank to learn more about financial requirement to qualify for reduced cost donor milk.

A new way to share milk began in 2004 with the development of the website Human Milk 4 Human Babies (www.hm4hb.com) and global Facebook group. Since that time, additional Internet opportunities have become available to share unpasteurized human milk. Milk sharing continues to grow in popularity. There are many concerns with stranger-to-stranger milk sharing. These concerns include unregulated, untested human milk with potential for infectious agents in the milk, and the potential for harmful medications to be present in the milk. These medications may be prescriptions, OTC, and/or recreational drugs. Additional concerns involve potential for contamination in pumping and cleaning breast pump practices and possible bioactive factor changes due to thaw/freeze cycles.[169] A study by Keim et al. purchased several containers of human milk and assessed bacterial counts as well as infectious contents. They reported that most Internet samples would have failed HMBANA criteria for feeding. The samples were frequently contaminated with overall high bacterial growth. Time-in-transit was predictive of bacteria counts. None of the Internet samples were HIV positive; however, 21 percent were cytomegalovirus DNA-positive. This is concerning, as many mothers seeking to purchase milk for medically fragile infants.[170] The AAP, the CDC, and the FDA do not support milk sharing or unpasteurized donor milk.

Prolacta, the first commercial for-profit milk bank, was established in 2006. This company has several specialized products for the NICU population including human milk fortification.[171]

7.12 Model Programs

Breastfeeding Promotion in Physicians' Office Practices (BPPOP)

The AAP receives funding support from the Maternal and Child Health Bureau (MCHB), USDHHS, and the AAP Friends of the Children Fund for this innovative program designed to boost breastfeeding promotion and support in underserved populations. Initiated in 1997, BPPOP's original mission was to improve the ability of AAP members to support new mothers and their breastfeeding infants and to encourage pediatricians to collaborate with others to develop breastfeeding promotion programs. Pediatricians enrolling in the program received a resource kit of educational materials and other strategies to more effectively promote, support, and manage breastfeeding with all families in their practice. In addition, pediatricians were provided technical assistance by telephone and email regarding breastfeeding concerns from AAP staff and were encouraged to participate in community and regional collaborative action groups. After over 700 pediatricians nationwide joined the program, BPPOP was expanded in 2002 (BPPOP II) to include obstetricians, family physicians, and other health-care providers and to specifically target office practices working with racially and ethnically diverse populations. A speaker's kit and materials targeting underserved populations were added to the resource kit, along with the newest strategies and opportunities for multidisciplinary networking for community breastfeeding promotion. Physicians joining the program complete a self-assessment questionnaire at the beginning and end of the program and measure the impact of breastfeeding promotion efforts by tracking the breastfeeding initiation and duration rates within their practices.

BPPOP II concluded in 2004. Gaps in the program were identified—including the need for focused training related to breastfeeding support and management. It also became evident that this training should occur well before physicians are in practice, preferably in residency and medical school. To address this shortcoming, the BPPOP program entered its third phase (BPPOP III) in 2008. This phase aimed to educate pediatric, obstetric/gynecologic, and family medicine

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residents. A pilot-tested breastfeeding residency curriculum was tested at 14 residency programs throughout the United States. The AAP has finalized this breastfeeding residency curriculum. Implementation strategies and use of the curriculum are available through the AAP.

Hear Her Campaign

The Hear Her Campaign supports the CDC to raise awareness of maternal warning signs during and after pregnancy. The campaign is supported through a partnership with the CDC Foundation and funding from Merck through the Merck for Mothers Program. This program supports all women postpartum including breastfeeding mothers. Dr. Wanda Barfield, Director of CDC's Division of Reproductive Health says "A woman knows her body. Listening and acting upon her concerns during or after pregnancy could save her life."[172] Approximately 700 women in the United States die every year from pregnancy complications. Two of three of those deaths are preventable. Considerable racial disparities exist in the United States with Black, Native American, and Alaska Native women being two to three times more likely to die of pregnancy-related causes compared to White women. Objectives of the campaign are to increase awareness of serious pregnancy-related complications and their warning signs, encourage women to speak up and raise concerns, encourage women's support systems to engage in important conversations with her, and provide tools for women and providers to do better to engage in life-saving conversations. Conversation guides are available to assist pregnant and postpartum women to identify concerns and share them with their health-care provider. Information and resources are also available for partners, friends, and family members to educate them on maternal warning signs to Hear Her concerns and save lives.[172]

The Rush Mothers' Milk Club

The Rush Mothers' Milk Club at Rush Presbyterian–St. Luke's Medical Center is an evidence-based program of breastfeeding interventions for the NICU.[173] The program uses a team approach to feeding very low-birthweight infants their own mothers' milk (OMM). The infants' mothers work in partnership with neonatologists, neonatal nurse practitioners, bedside nurses, and other health-care professionals to ensure that the latest research is applied to an infant's OMM feeding plan. Interventions to sustain lactation for program participants have evolved from the evidence about barriers to providing OMM to NICU infants. They include preventing and treating low milk volume, achieving adequate infant growth on OMM feedings, and making the transition to at-breast feedings in the NICU and post-discharge periods. Additionally, research about the effectiveness of peer support to sustain lactation has been incorporated into the program.[173]

Major program components include (1) providing information for mothers to make an informed decision, (2) providing access to a hospital-grade electric breast pump, (3) providing skin-to-skin care and suckling at the empty breast as practice for the newborn, (4) babies feeding at the breast as soon as they are able to suck and swallow effectively, and (5) nursery staff helping the mother prepare for breastfeeding after discharge (www.rush.edu/patients/children/publications/notes/preemies.html). The club serves as a place for mothers to discuss their goals and concerns about breastfeeding. Mothers learn the value of their milk to their high-risk baby from the Special Care Nursery Staff and from the Rush Mothers' Milk Club. The mothers learn to measure the amount of fat and calories in their own milk and learn to capture the highest-calorie portion of milk, which is usually produced during the last 10 minutes of pumping. To create a bond between the mother and baby, mothers are encouraged to use the breast pumps at the baby's bedside. Family members and friends are also encouraged to participate in the weekly Rush Mothers' Milk Club meetings to learn the importance of breastfeeding to the high-risk infant.

The success of the Rush Mothers' Milk Club is measured by its breastfeeding initiation rates. Between 95 and 97 percent of all mothers who deliver high-risk infants at Rush Presbyterian–St. Luke's Medical Center begin to nurse, compared with national rates for high-risk infants of only 30–40 percent. A group of low-income African American mothers who delivered babies below 1,500 g had OMM initiation rates of 63.4 percent, the highest reported rates for this population in the nation.[173] The program has evidence that these high rates of initiation are due to two primary interventions: the clarity of the message that the mothers received about the importance of OMM from health-care providers and their immediate access to electric breast pump rental.

Key Points

1. The majority of mothers and infants do not experience significant problems with breastfeeding. Many of the more common problems can be prevented through prenatal breastfeeding education and from informed, consistent, and individualized care and support from health professionals, both in the hospital and after discharge.
2. Most medications (prescription or over the counter) and herbal supplements taken by the mother are excreted in her breast milk and should not be ingested until the risks to the infant are established. For most maternal conditions, required drug therapy choices are available that will not cause harm to the breastfeeding infant; recommending that a mother discontinue breastfeeding to take a medication is rarely required.
3. The level of alcohol in breast milk matches the maternal plasma alcohol levels at the time of the

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infant feeding; a nursing woman who drinks occasionally can limit her infant's exposure to alcohol by timing breastfeeding in relation to her drinking.

4. Maternal smoking presents significant health risks for infants and children. Data show that children of smoking mothers who are breastfed have better general health, and decreased respiratory illness and risk of sudden infant death syndrome, compared to children of smoking mothers who were not breastfed.
5. While low levels of environmental pollutants are present in most human milk, their impact on the well-being of the mother and infant is unknown. The WHO and other scientific groups state that the advantages of breastfeeding far outweigh the potential risks from environmental pollutants and recommend breastfeeding in all but extreme circumstances.
6. A thorough understanding of the normal and abnormal patterns and mechanisms of jaundice (hyperbilirubinemia) in the newborn period is important for all health professionals to prevent toxicity from excessive jaundice and for protecting and ensuring successful breastfeeding. Early and frequent breastfeeding (at least 8–12 times in 24 hours) in the first days of life helps prevent hyperbilirubinemia through maintaining infant hydration and stimulating the passage of stool. The AAP recommends against routine supplementation of nondehydrated breastfed infants with water or dextrose water, as this practice will not prevent jaundice.
7. Twins and other multiples can be successfully breastfed without supplementation.
8. Exclusive breastfeeding for at least 4 months is recommended to protect against ectopic dermatitis and wheezing illnesses in at-risk children up to age 10. If there is no history of allergy to a specific food in the mother's or father's family, avoiding a food because it is a potential allergen is an unnecessary precaution.
9. Human milk is the preferred food for all premature and sick newborns, with rare exceptions. Appropriately fortified pasteurized human milk should be used for the preterm and/or sick infant.
10. In developed countries, where safe and affordable breast milk substitutes are available, women living with HIV or AIDS should be counseled strongly not to breastfeed to prevent mother-to-child transmission of HIV through breast milk.
11. Health professionals should provide breastfeeding mothers with current evidence-based guidelines for the collection (through hand pumps, electric handheld pumps, hospital-grade electric breast pumps, or manual expression) and storage of human milk for home use or human milk banking.
12. In most situations, the medical problems of the mother or infant can be managed without discontinuing breastfeeding. Any medical decision to limit breastfeeding must be justified by the fact that the risk to the infant clearly outweighs the benefits of breastfeeding.

Review Questions

1. List three common causes of persistent nipple pain.
2. Signs of a hyperactive letdown are:
   a. Milk streams quickly
   b. Infant may be overwhelmed by the volume
   c. Infant may choke, cough, or gulp
   d. All of the above.
3. List three reasons a breastfeeding mother may develop mastitis.
4. Before a mother uses galactogogues to improve supply, she should be pumping with a hospital-grade electric pump every 2–3 hours during the day and once at night or she should be pumping after each feeding.

   _____ True _____ False
5. The alcohol level in breast milk matches maternal plasma levels.

   _____ True _____ False
6. Smoking can lower milk production and decrease fat content.

   _____ True _____ False
7. The main obstacle to nursing multiples is milk supply.

   _____ True _____ False
8. List at least three major risk factors for developing severe hyperbilirubinemia.
9. Preterm infants have higher readmission rates because of:
   a. Hypoglycemia
   b. Suck–swallow coordination
   c. Hypothermia
   d. All of the above.
10. Marijuana is excreted into breast milk at what ratio compared to maternal plasma levels?
    a. Twofold
    b. Fourfold
    c. Sixfold
    d. Eightfold

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Lt. Cmdr. Gary Brunette/Center for Disease Control

8

Infant Nutrition

Prepared by Robyn Wong

Learning Objectives

After studying the materials in this chapter, you should be able to:

8.1 List factors that are associated with increased risk for health and developmental problems in infants.

8.2 Describe guidelines and tools that can be used to determine appropriate energy and nutrient needs of infants.

8.3 Describe how to assess adequate growth in infants.

8.4 Discuss how feeding and food choices that parents make for their infants can affect later health status.

8.5 Identify infant developmental milestones related to feeding.

8.6 Describe how families and caregivers can access nutrition guidance for infants.

8.7 Identify how nutrition problems may affect infant health and development.

8.8 Cite examples of nutritional interventions that can reduce risk for nutrition and health problems in infancy.

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Introduction

Rapid growth during the first year of life differentiates infancy from all other ages.[1] From birth to 6 months of age, growth occurs most rapidly than at any other period in the life cycle.[2] Infancy is a critical period for brain formation, and adequate nutrition is required for normal brain development. The foundation for cognitive, motor, and socio-emotional skill development is established, and these skills will continue to progress through childhood and adulthood.[3] This is also the period when feeding skills and healthful eating patterns are being established.

This chapter is about healthy **full-term infants** born at or after 37 weeks of gestation.[4] These infants are expected to achieve normal patterns of growth and development in their first year. Infants generally double their birth weight by 4–6 months of age, and triple their birth weight at 1 year of age.[5] At the end of the first year, birth length will increase by 55 percent.[5] Head circumference is reflective of brain growth, and the weight of the newborn brain will double by 1 year of age.[5]

This chapter discusses how nutrition is an important component in the complex development of infants. Both biological and environmental factors interact during infant growth and development. Models about the interaction of biological and environmental factors are often incomplete. They are not always adequate for describing complex interactions, such as how mealtime stimulates language development and how food preferences develop during infancy. Failing to provide adequate macronutrients and micronutrients at critical periods in brain development can have long-lasting effects.[6]

The Healthy People 2030 objectives related to infant health target reductions in infant deaths and preterm births, and increases in the proportion of infants who exclusively breastfeed through age 6 months, and are breastfed at 1 year.[7] Table 8.1 lists some of the infant-related 2030 objectives that are tracked by public health indicators.

8.1 Assessing Newborn Health

Birthweight and Gestational Age as Outcome Measures

The birthweight of a newborn is one of the indicators of the infant's health status. Full-term infants, born at 37 to 42 weeks gestation, usually weigh between 2,500 and 3,800 g (5.5–8.5 lb).

Table 8.2 Classification of infants

Gestation	
Term	37–42 weeks gestation
Late preterm	34 to 36 6/7 weeks gestation
Preterm	28 to 33 6/7 weeks gestation
Extremely preterm	<28 weeks gestation
Birth Weight	
Low birth weight	<2,500 grams
Very low birth weight	<1,500 grams
Extremely low birth weight	<1,000 grams

There were over 3.747 million births in the United States in 2019; this is a 1 percent decline from 2018.[8]

Full-term infants with normal birth weights are generally healthy, and less likely to require intensive care. Premature or **preterm infants** are born before 37 weeks gestation and are classified by their gestational age and birth weight. Length of gestation and birthweight are two of the most important predictors of an infant's survival and later health.[7] Table 8.2 identifies the parameters used when classifying newborn infants by gestation and birth weight.

Very preterm and very low-birthweight infants are at much greater risk of death and disability than infants born at term or with birth weights over 2,500 g.[9] In 2019, the preterm birth rate in the United States was 10.23 percent. This was a 2 percent increase from 2018, and the fifth straight year of rate increase.[8]

Infant Mortality

Infant mortality is one of the key indicators of the overall health of a nation. It is associated with numerous factors including maternal health, quality and access to medical care, socioeconomic conditions, and public health practices. In 2019, the infant mortality rate in the United States was 5.6 deaths per 1,000 live births. This rate reflects no significant

full-term infants	Infants born at or after 37 weeks of gestation.
preterm infants	Infants born before 37 weeks of gestation.
infant mortality	Death that occurs within the first year of life.

Table 8.1 United States 2030 Healthy People Objectives related to infants

Selected Goals in Maternal, Infant, and Child Health	Baseline	Target
Reduce the rate of infant deaths	5.8 infant deaths per 1,000 live births	5.0 per 1,000 live births
Reduce preterm births	10.0% of live births	9.4%
Increase the proportion of infants who are put to sleep on their backs	78.7%	88.9%
Increase the proportion of infants who are breastfed exclusively through age 6 months	24.9%	42.4%
Increase the proportion of infants who are breastfed at 1 year	35.9%	54.1%

Source: Healthy People 2030 Objectives. Available at https://healthypeople.gov/, accessed February 26, 2023.

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change from 2018.[9] The leading causes of infant mortality in the United States in 2019 were congenital malformations, low birth weight, maternal pregnancy complications, sudden infant death and unintentional injuries.[9]

The infant mortality rate is defined as the number of deaths of children less than 1 year of age per 1,000 live births. In 2018, the infant mortality rate in the United States was 5.7. This compares to an average of 4.1 for the 36 countries in the Organization for Economic Co-operation and Development (OECD) in the same year. The higher infant mortality rate in the United States has been associated with a higher proportion of babies weighing less than 500 grams at birth and have lower odds of survival.[10]

Combating Infant Mortality

In the United States, much of the efforts to reduce infant mortality have focused on preventing preterm and low-birthweight deliveries, birth defects, injuries, sudden infant death, and pregnancy complications. Successful efforts contributing to a decline in this rate include improvements in specialized care for mothers and infants.

This is a multifaceted problem, however, and in the United States there are disparities related to:

- Race/ethnicity – mortality rate was highest in infants of non-Hispanic Black women, nearly twice the rate of non-Hispanic White women. Infant mortality rates associated with sudden infant death syndrome and congenital malformations were notably higher for non-Hispanic Black than non-Hispanic White infants.[11]
- Socioeconomic status – individuals with incomes below the federal poverty threshold are disproportionately affected by access to and quality of health care.[12] Disadvantaged socioeconomic status is associated with preterm birth and is independent of race.[13]
- Geographic location – in 2019 infant mortality rates were highest among states in the southern United States.[9]

Health Outcomes of High-Risk and At-Risk Infants

Medicaid and the Children's Health Insurance Program (CHIP) provide health-care coverage that is free or low-cost and contribute to improved access to quality health care for high-risk and at-risk infants. Well-child visits and dental visits are free under CHIP.[14]

EPSDT The Early and Periodic Screening, Diagnostic, and Treatment benefit is a part of the Medicaid program and provides coverage for routine well-child visits and dental visits for enrolled children.

intrauterine growth restriction (IUGR) Fetal undergrowth from any cause, resulting in a disproportionately low weight, length, or head circumference percentile for gestational age.

The **Early and Periodic Screening, Diagnostic, and Treatment** (**EPSDT**) benefit provides comprehensive and preventive health-care services for children under 21 years of age who are enrolled on the Medicaid Program. Benefits vary by state and there may be co-pays or a monthly premium for other services.[15] Immunizations in infancy are another example of a public health prevention-focused program.

Bright Futures national health promotion and prevention initiative is a collaborative project led by the American Academy of Pediatrics (AAP) and supported in part by the U.S. Department of Health and Human Services, Health Resources and Services Administration (HRSA), Maternal and Child Health Bureau (MCHB). The mission of the Bright Futures initiative is to promote and improve the health, education, and well-being of infants, children, adolescents, families, and their communities.[16] This project has developed exemplary health supervision guidelines, tools, and materials for practitioners working with the pediatric population. *Bright Futures Nutrition* is an excellent publication and series of tools and materials which focus on improving the nutritional health of infants, children, adolescents, and children with special health-care needs.[17]

Newborn Growth Assessment

Newborn health status is assessed by various indicators of growth and development taken right after birth. Indicators include gestational age, birthweight, length, and head circumference. The designation "small for gestational age" (SGA) indicates that the newborn's weight, length, or head circumference plots below the 10th percentile on the growth chart. When all three measurements fall below the 10th percentile, the infant is symmetrically small for gestational age. Measurements above the 90th percentile are considered large for gestational age (LGA) and more often are noted in infants of diabetic mothers. Appropriate for gestational age (AGA) infants have birth measurements that plot between the 10th and the 89th percentile. SGA, AGA, and LGA are indicators of the infant's size at birth. Another indicator, **intrauterine growth restriction (IUGR)**, is a medical diagnosis identified antenatally. The etiology of IUGR may be associated with genetic factors, congenital anomalies, infection, multiple gestation, maternal nutrition, environmental toxins, placental factors and maternal vascular disease such as diabetes, chronic hypertension, advanced maternal age, and severe obesity. IUGR is a significant factor in perinatal morbidity and mortality.[18]

Normal Physical Growth and Development

There is now evidence that the rate and progression of early growth are major risk factors for development of certain chronic diseases including coronary heart disease and type 2 diabetes.[19] Monitoring infants' nutritional status requires an understanding of their overall development. Full-term newborns have a wider range of abilities than previously recognized; for example, they hear and move in response to familiar sounds, such as their mother's voice.[20] States of arousal describe sleep and awake states in

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infants and affect the way they respond at any given time. They provide a framework for parents and caregivers to observe, understand, and interact with their infants. For newborns, states of consciousness allow them to control the type and amount of input they receive from their environments. These states will change considerably in the first month of life. They include deep sleep, light sleep, drowsy, quiet alert, active alert, and crying.[21]

At birth, the infant's brain weighs 12 ounces; this is approximately 25 percent of the weight of an adult brain. It will continue to grow rapidly in infancy and the preschool years.[20] Because the newborn's central nervous system is immature, the neurons in the brain are less organized compared to those of the older infant. As a result, the newborn gives inconsistent or subtle cues of hunger and other needs, compared to the cues given at a later age. Newborns are **rooting,** able to **suckle**, and coordinate sucking, swallowing, and breathing within hours of birth; this shows that feeding is directed by **reflexes** and the central nervous system.[19,20] Newborn reflexes are protective. These reflexes later fade as they are replaced by more purposeful movements during the first few months of life (Table 8.3).[20]

Motor Development

Motor development reflects an infant's ability to control voluntary muscle movement. There are several models for describing infant development, but none provides a complete description and explanation of the rapid advances in motor skills achieved during infancy.[20] Figure 8.1 depicts gross motor development during the first 15 months.[20]

It is a great source of pride for parents when their baby first rolls over or sits up. Motor development influences both the ability of the infant to feed and the amount of energy expended in the activity. The ability to sit in a high chair is an example of how motor development affects feeding. When an infant has achieved head and trunk control, sitting balance, and fading of certain reflexes such as tongue thrust, oral feeding can be initiated. As motor skills continue to progress, daily energy needs increase because of higher energy expenditure. Infants who are crawling or starting to walk will expend more energy in physical activity than younger infants who are not yet rolling over. Table 8.4 identifies key developmental milestones suggestive of infant readiness for solid foods.

Critical Periods

The concept of critical period is based on a fixed time period when certain behaviors emerge. A critical period for the development of oral feeding skills may explain some later feeding problems in infancy. In a healthy newborn, the mouth is a source of oral pleasure and exploring, an important form of early learning. An infant on prolonged respiratory support may not associate oral sensations and stimulation with pleasure, but instead with discomfort. The critical period for developing positive associations with oral experiences and feeding may have adversely been affected. After discharge, this infant may show less interest in feeding and mealtimes. Feeding issues that may occur in preterm infants and infants with special health-care needs will be discussed in Chapter 9.

Cognitive Development

Risk factors for poor cognitive, motor, and socio-emotional development include severe, acute malnutrition (very low weight for length), chronic undernutrition (intrauterine growth restriction, and slow linear growth or stunting), iron-deficiency anemia, and iodine deficiency.[3] The baby's interactions with the environment stimulate the developing brain, and contributes to ongoing structuring of the nervous system. Research has shown that access to adequate energy and protein alone may not be sufficient for maximizing brain maturation without simultaneously providing psycho-social stimulation.[22]

rooting reflex an involuntary action that occurs when the infant's mouth or check is stroked resulting in the infant's head turning toward the stimulus and opening his or her mouth.

suckle A reflexive movement of the tongue moving forward and backward; earliest feeding skill.

reflex An automatic (unlearned) response that is triggered by a specific stimulus.

Table 8.3 Some major reflexes found in newborns

Name	Response	Significance
Babinski	Baby's toes fan out when the sole of the foot is stroked from heel to toe.	Perhaps a remnant of evolution
Blink	Baby's eyes close in response to bright light or loud noise.	Protects the eyes
Moro	Baby throws arms out and then inward (as if embracing) in response to loud noise or when head falls	May help a baby cling to the mother
Palmar	Baby grasps an object placed in the palm of his or her hand.	Precursor to voluntary grasping
Rooting	When a baby's cheek is stroked, baby turns head toward the stroking and opens mouth.	Helps a baby find the nipple
Stepping	Baby held upright by an adult and is then moved forward begins to step rhythmically	Precursor to voluntary walking
Sucking	Baby sucks when an object is placed in mouth.	Permits feeding

Source: Kail, R. V., Cavanaugh, J. C. *Human Development*, 8th ed, 2019.

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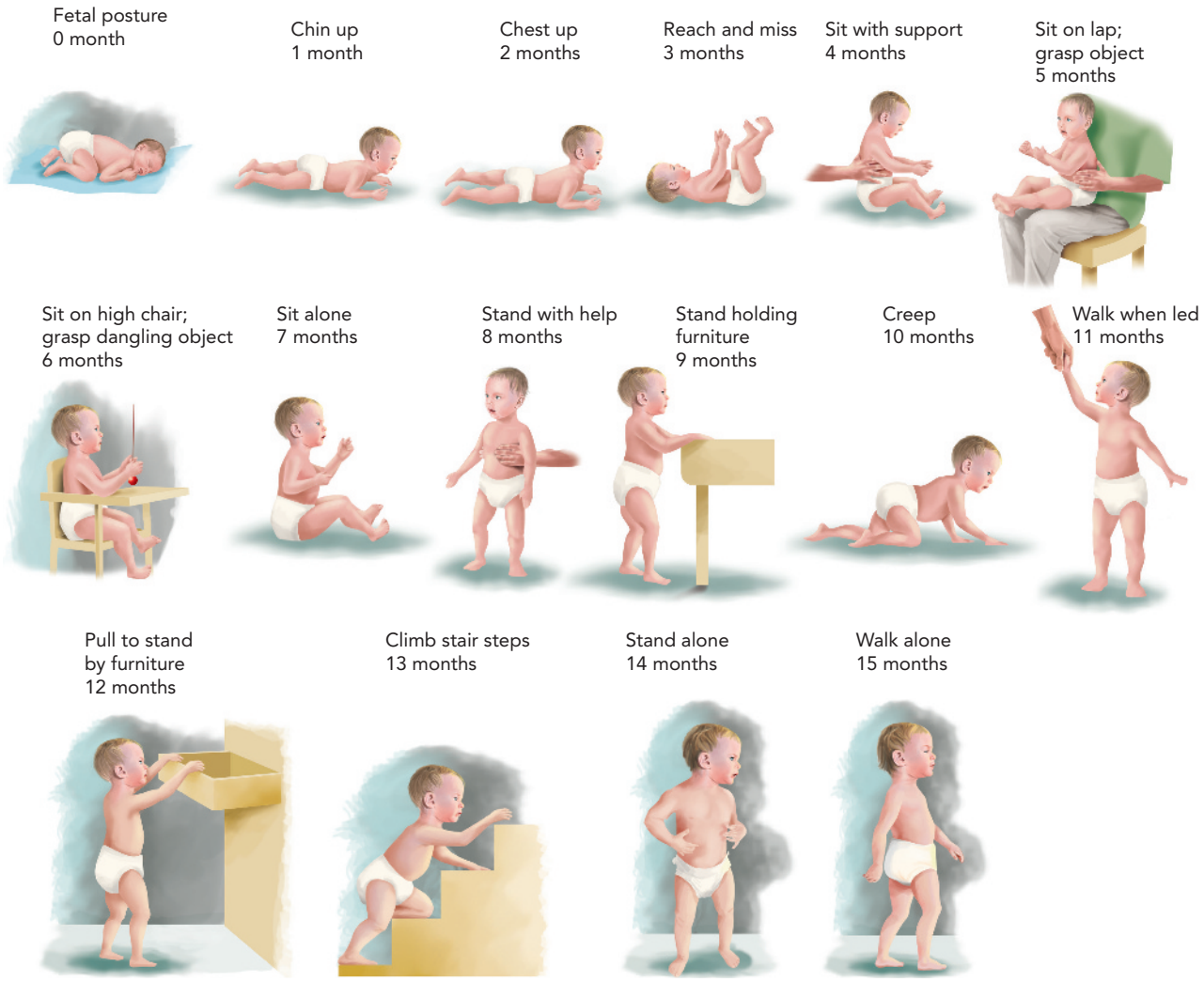


Figure 8.1 Gross motor skills.

Based on Shirley, 1931, and Bayley, 1969.

Source: From Kail, R. V, & Cavanaugh, J. C. *Human Development: A Lifespan View*. 8th ed, Cengage Learning, 2019.

Table 8.4 Key developmental milestones and readiness for feeding

• Truncal strength and stability enable the infant to sit in upright position with or without support
• Primitive reflexes are fading or no longer present. These include sucking, rooting, and extrusion or tongue thrust reflexes
• Oral-motor skills are emerging to handle nonliquid foods

Source: American Academy of Pediatrics. Complementary Feeding. In: Kleinman, R. E., & Greer, F. (Eds). *Pediatric Nutrition*, 8th ed. Itasca, IL: American Academy of Pediatrics: 2020:163–186.

Improving the nutritional status of infants can positively affect their environment-related experiences and stimulation. Infants who do not consume adequate nutrition may frequently be ill and subsequently irritable, fussy, tired, and withdrawn. Caregivers may experience more difficulty when feeding these infants. A decreased activity level may occur and alter their ability to explore their environment and interact with their caregivers. Poor brain development may result.[3]

Digestive System Development

A healthy digestive system is necessary to support adequate nutrition. Parents may worry about gastrointestinal problems, in part because of misinformation about nutrition in infancy.[23] An infant passing soft, runny stools may be thought to have diarrhea if parents do not know that these are typical stools of breastfed infants. Parents may feel that their infant's gastrointestinal discomfort may affect and interfere with weight gain, even though growth has been progressing well. It takes up to 6 months for the infant gastrointestinal tract to mature, and the time required is variable among infants.[24]

During the third trimester, the fetus swallows amniotic fluid, and this stimulates the lining of the intestine to grow and mature. At birth, the healthy newborn's digestive system is sufficiently mature to digest fats, protein, and simple sugars and to absorb fats and amino acids. Although healthy newborns do not have the same levels of digestive enzymes or rate of gastric emptying as

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Table 8.5 Hunger and fullness cues

Age	Hunger Signs	Fullness Signs
Birth through 5 months	• Wakes and tosses • Sucks on fist • Cries or fusses • Opens mouth while feeding	• Seals lips together • Turns head away • Decreases or stops sucking • Spits out the nipple or falls asleep when full
4 through 6 months	• Cries or fusses • Smiles, gazes at caregiver or coos during feeding • Moves head toward spoon or tries to swipe food towards mouth	• Decreases rate of sucking or stops sucking when full • Spits out the nipple • Turns head away • May be distracted or pay more attention to surroundings
5 through 9 months	• Reaches for spoon or food • Points to food	• Eating slows down • Pushes food away
8 through 11 months	• Reaches for food • Points to food • Gets excited when food is presented	• Clenches mouth shut or pushes food away
10 through 12 months	• Expresses desire for specific food with words or sounds	• Shakes head to express "no more"

Source: Perez-Escamilla, R., et al. On behalf of the Robert Wood Johnson Foundation Healthy Eating Research Panel. Feeding Guidelines for Infants and Toddlers: A Responsive Parenting Approach, 2017.

older infants, the gut is functional at birth[24] After birth and through early infancy, the coordination of peristalsis within the gastrointestinal tract improves.

Infants may have conditions that reflect the immaturity of the gut, such as colic, **gastroesophageal reflux (GER)**, unexplained diarrhea, and constipation.[25] Such conditions do not usually interfere with the ability of the intestinal villi to absorb nutrients, and typically do not hinder growth.[26] Many factors influence the rate of food passage through the colon and the gastrointestinal discomfort seen in infants. These include:

- Osmolality of liquids, which affects how much water is drawn into the intestine
- Bacterial flora in the colon
- Water and fluid balance in the body

Parenting

Even though the newborn is able to breastfeed or bottle feed soon after birth, skills of new parents may develop slowly. The parents' ability to recognize and respond to infant cues of hunger and satiety improves over time. Table 8.5 highlights some of the hunger and satiety cues observed at varying ages during the first year of life. New parents are also learning about the temperament of their infants. Infant temperament related to feeding includes emotionality, activity, attention span and persistence, reaction to food, and soothability.[27] Infants also have variable eating styles, which can be seen in their reaction to foods, predictability of appetite, and distractibility at mealtime. The infant's temperament and eating style might be related to potential feeding problems and risk for obesity in childhood.[27]

A healthy parent–infant feeding relationship involves responsive parenting. Table 8.6 provides guidelines which support a responsive feeding environment.

Table 8.6 Recommended Responsive Feeding Guidelines

Recommended Responsive Feeding Guidelines include:

- Ensuring that the feeding environment is pleasant with few distractions (e.g., no television or other screens)
- Ensuring the child is seated comfortably, ideally facing others
- Ensuring that the expectations from caregiver and child are communicated clearly and consistently
- Ensuring the food is healthy, tasty, developmentally appropriate and offered on a predictable schedule so the child is likely to be hungry
- Encouraging and attending to the child's signals of hunger and satiety
- Responding to the child's feeding needs in a prompt, emotionally supportive, contingent and developmentally appropriate manner

Source: Black, M. M., & Aboud, F. E. Responsive feeding is imbedded in a theoretical framework of responsive parenting. *J Nutr.* 2011; 141(3):490–494.

Parental skills that support healthful feeding and eating in infancy include:

- Responding early and appropriately to the infant's hunger and satiety cues
- Recognizing the infant's developmental abilities and feeding skills
- Balancing the infant's need for assistance with encouragement of age-appropriate feeding skills
- Allowing the infant to initiate and guide feeding interactions[17]

gastroesophageal reflux (GER) Movement of the stomach contents upward into the esophagus and may cause spitting up or regurgitation. The condition may require treatment depending on its duration and degree. Most children outgrow GER by 12 to 14 months of age.[26]

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8.2 Energy and Nutrient Needs

Well-researched nutrient and energy recommendations have been established by the Food and Nutrition Board, Institute of Medicine, and the National Academies of Sciences. The Dietary Reference Intakes (DRIs) have identified age-specific recommendations for energy and for macro and micronutrients for healthy infants from 0 to 6 months and from 7 to 12 months of age. These DRIs are listed in Table 8.7.

The National Academies of Sciences, Engineering, and Medicine recently published *Feeding Infants and Children from Birth to 24 Months: Summarizing Existing Guidance*. This report reviewed and analyzed existing birth to 24-month feeding guidelines from domestic and international organizations. There were differences in the way these guideline documents were developed; and consistency in a majority of the recommendations across these organizations.[28]

The 2020–2025 Dietary Guidelines for Americans (DGA) include for the first time recommendations for infants and young toddlers up to two years of age. Table 8.8 lists these key nutritional goals for infants.[29]

Energy Needs

The energy needs of infants per kilogram body weight are higher than at any other time of life. The range in energy requirements for individual infants is broad, ranging from 80 to 120 kilocalories (kcal) per kg body weight.[30] The average energy need of infants in the first 6 months of life is 108 kcal per kg body weight and is based on growth in breastfed infants. From 6 to 12 months of age, the average energy need is 98 kcal/kg.[30] Factors that account for the range of energy needs of infants include:

- Weight
- Growth rate
- Sleep/wake cycle
- Temperature and climate
- Physical activity
- Metabolic response to food
- Health status and recovery from illness

Table 8.7 Dietary Reference Recommendations for Infants[30,39,43,50]

Nutrient	0–6 months	7–12 months
Protein (g)	9.1*	11**
Carbohydrate (g)	60*	95*
Fat (g)	31*	30*
Calcium (mg)	200*	260*
Iron (mg)	0.27*	11**
Sodium (mg)	120*	370*
Potassium (mg)	400*	860*
Zinc (mg)	2*	3**
Vitamin A (mcg)	400*	500*
Vitamin C (mg)	40*	50*
Vitamin D (mcg)	10*	10*
Vitamin B_{12} (mcg)	0.4*	0.5*
Vitamin B_1 (Thiamin, mg)	0.2*	0.3*
Vitamin B_2 (Riboflavin, mg)	0.3*	0.4*
Vitamin B_3 (Niacin, mg)***	2*	4*

*Adequate Intake (AI)

**Recommended Dietary Allowance (RDA)

***As niacin equivalents (NE). 1 mg of niacin = 60 mg of tryptophan; 0–6 months = preformed niacin (not NE)

Table 8.8 Dietary Guidelines, 2020–2025[29]

Key Recommendations for Infants
For about the first 6 months of life, exclusively feed infants human milk. Continue to feed infants human milk through at least the first year of life, and longer if desired.
Feed infants iron-fortified formula during the first year of life when human milk is unavailable.
Provide infants with supplemental vitamin D beginning soon after birth.
At about 6 months, introduce infants to nutrient-dense complementary foods.
Introduce infants to potentially allergenic foods along with other complementary foods.
Encourage infants and toddlers to consume a variety of foods from all food groups.
Include foods rich in iron and zinc, particularly for infants fed human milk.
Avoid foods and beverages with added sugars.
Limit foods and beverages higher in sodium.
As infants wean from human milk or infant formula, transition to a healthy dietary pattern.

Protein Needs

The recommended protein intake for infants from birth to 6 months of age is 1.52 grams per kg body weight, and 1.2 grams per kg from 7 to 12 months of age.[30] Protein requirements of infants are affected by age, growth, illness, and adequacy of other nutrients in the diet, and possibly genetic variation.[31] Essential amino acids requirements for healthy infants remain the same throughout the first year of life.[30]

Infants from birth to 6 months of age who are breastfed or who consume appropriate amounts of infant formula will obtain adequate protein. Infants may exceed protein recommendations if they consume excessive formula or if protein sources such as infant cereal are added to bottles of formula. Inadequate or excessive protein intake can occur with improper mixing of formula.

Fat Needs

Fat is an essential component in the diets of infants. It provides essential fatty acids, is a concentrated source of energy, and facilitates the absorption of the fat-soluble vitamins A, D, E and K. Fat is especially important in infancy and early childhood because it is essential for neurological development and brain function.[32]

Infants are at higher risk for essential fatty acid deficiency related to their rapid growth rate and higher requirements for polyunsaturated fatty acids. They also have limited stores of body fat.[33] Restriction of fat and dietary cholesterol are not recommended in infancy.

The Adequate Intake (AI) for fat is 31 g per day for infants 0–6 months of age and 30 grams per day for infants

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7–12 months of age.[30] Fat contributes approximately half of the calories in breast milk[2,34] and 40–50 percent of calories in infant formulas.[35] The percentage of fat in the diet will decrease as the infant accepts complementary foods, since most complementary foods are low in fat.

Infants use fat to supply energy to the liver, brain, and muscle, including the heart. The fact that infants have higher energy needs per kg body weight than children means that infants use fat more regularly for generating energy. Young infants cannot tolerate fasting for long because it quickly uses up both their carbohydrate and fat stores. This effect of fasting explains in part why young infants cannot sleep through the night.

Fats in food provide the essential fatty acids linoleic acid (LA) and alpha-linolenic acid (ALA), and polyunsaturated fatty acids, including docosahexaenoic acid (DHA) and arachidonic acid (ARA). Essential fatty acids are substrates for hormones, steroids, endocrine, and neuroactive compounds. DHA is a major fatty acid in brain and retinal phospholipids.[32]

Metabolic Rate, Energy, Fats, and Protein—How Do They All Tie Together?

The metabolic rate of infants is the highest of any period after birth.[16] The higher rate is primarily related to infants' rapid growth rate and high proportion of muscle. The usual body fuel for metabolism is glucose. When sufficient glucose is available, growth will typically progress. When glucose from carbohydrates is limited, amino acids will be converted into glucose to generate energy and become less available for growth. The conversion of amino acids into glucose is a more dynamic process in infants than in adults. The breakdown of amino acids for use as energy occurs during illness in adults, but it can occur daily in fast-growing infants. Circulating amino acids in the blood from ingested foods will be used for glucose production, and if these are not sufficient, the body will release amino acids from muscles. This process of breaking down body protein to generate energy is known as catabolism. If catabolism continues for an extended duration, it can contribute to growth faltering in infants.

Other Nutrient and Non-Nutrient Needs

Fluoride Fluoride is a naturally occurring mineral compound that can contribute to the prevention and reduction of dental caries. When ingested during the time that teeth are developing the fluoride will be deposited on tooth surfaces. The maximum reduction in dental caries will be achieved when fluoride is provided systemically while teeth are developing and topically after teeth are present in the mouth. Fluoride helps to reduce tooth decay by decreasing the solubility of tooth enamel, decreasing the production of acid by oral bacteria, and by supporting further remineralization. Dental caries are the most common chronic disease of childhood and prevalence is high among socioeconomically disadvantaged groups, and children with special health-care needs.[36]

Infants can obtain fluoride from fluoridated water, bottled water with added fluoride, and from fluoride supplements. Fluoride content in breast milk is low.[37]

Community water fluoridation is a safe, cost-effective way of preventing tooth decay by up to 25 percent.[38] It is one of the objectives in Healthy People 2030: to increase the proportion of people whose water systems have the recommended amount of fluoride from 72.8 percent to 77.1 percent.[7]

The DRI for fluoride is 0.1 mg daily for infants less than 6 months of age, and 0.5 mg daily for infants 7–12 months old.[39] Most infants who live in areas with fluoridated water do not need additional fluoride. Supplemental fluoride is recommended for breastfed and formula-fed infants residing in communities where fluoride concentration in the water is low; beginning at 6 months of age.[36]

Vitamin D Vitamin D is a key nutrient in the diets of infants. It has an essential role in bone mineralization and calcium and phosphorus homeostasis, and regulates genes associated with immune response and cellular growth.[40] There are two forms: vitamin D_2 (ergocalciferol), which is from plants and fungi, and vitamin D_3 (cholecalciferol), which is synthesized in the skin during exposure to sunlight. Vitamin D_3 also is found in fatty fish like salmon and mackerel. The AI for vitamin D is 10 mcg daily. Breast milk is low in vitamin D at 0.55 mcg per liter.[41] Standard infant formulas manufactured in the U.S. contain 10 to 12 mcg of vitamin D per liter.

The AAP and the Dietary Guidelines for Americans 2020–2025 recommend that all breastfed and partially breastfed infants receive 400 IU of vitamin D daily, beginning soon after birth. Formula-fed infants who are consuming less than 1 liter of infant formula daily should receive 400 IU of vitamin D daily.[42] Vitamin D needs during lactation are discussed in Chapter 6.

Sodium Sodium is a major component of extracellular fluid and an important regulator of fluid balance. The AI for sodium is 120 mg for 0- to 6-month-old infants and 370 mg for 7- to 12-month-old infants.[43] The sodium content in breast milk was used as the basis for establishing sodium requirements for infants. Infant formula is supplemented with sodium to match the amount contained in breast milk.[43] Infants generally do not have difficulty with maintenance of body fluids and electrolytes, even though they may not show thirst as a separate signal from hunger. Young infants do not sweat as much as older children, so losses from sweating are not usually problematic. Illnesses such as diarrhea or vomiting cause the loss of fluid and sodium and increase the risk of dehydration. Infants do not need the addition of salt to foods to achieve adequate sodium intakes. The Dietary Guidelines for Americans 2020–2025 recommends that foods higher in sodium should be avoided in the diets of infants and young toddlers.[29]

Iron Infants are at risk for iron deficiency because of rapid growth in the first year. From 4 to 12 months of age, an infant's blood volume will double.[44] Those with lower iron stores at birth or low intakes of dietary iron are also at risk. Iron-deficiency anemia in infancy is associated with short- and long-term consequences, including poor cognitive and motor development. These infants have been reported with socio-emotional impairments including being more wary,

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hesitant, solemn, unhappy, and more closely keeping with their mothers.[45] Newborns at risk for iron deficiency include infants of diabetic mothers, growth-restricted (IUGR and/or small for gestational age) newborns, and preterm infants.[46]

Young infants have iron levels that reflect their mother's health during late pregnancy and delivery. Infants born at term generally have adequate iron stores that will last through 4–6 months of age.[44] According to the Institute of Medicine, healthy-term infants 0–6 months of age need 0.27 mg of iron each day. This AI recommendation was based on the iron content in breast milk, and the average breast milk intake of infants at this age. The recommended dietary allowance (RDA) for older infants 7–12 months of age increases to 11 mg daily related to the depletion of their iron stores that occurs 4–6 months after birth.[43,47] To assure that preterm, full term, and older infants have sufficient iron regardless of the method of feeding, the AAP recommends the following:

Preterm infants:	2–4 mg per kg through 12 months of age
Term infants:	
Exclusively breastfed:	1 mg per kg starting at 4 months of age
Formula fed:	No additional iron needed

Start iron-containing complementary foods after 4 to 6 months of age. Whole milk should not be used before 12 completed months of age.[48]

Zinc

Zinc is an essential nutrient in cellular processes and in the function of enzymes that regulate major metabolic pathways of the body. It has a role in immune function, hormone metabolism, regulation of gene expression, wound healing, taste acuity, and growth and development. Human milk initially contains high concentrations of zinc; subsequently there is a sharp decline in zinc content.[49]

Recommended intakes of zinc for infants are based on Adequate Intake (AI); this reflects the mean zinc intake of exclusively breastfed infants.

0–6 months	2 mg per day
7–12 months	3 mg per day

The Dietary Guidelines for Americans 2020–2025 recommends introducing zinc-rich foods to infants starting at about 6 months of age.[29] Best sources of zinc are red meats; pork and poultry are moderate sources. Fish and eggs are the lowest in zinc content of animal products. Whole grains and legumes have moderately high concentrations of zinc however the absorption is inhibited by phytate and fiber.[49]

8.3 Growth Assessment

Physical growth is defined as the increase in body mass that occurs in genetically determined rates, patterns, and ages as a healthy infant grows into adulthood.[5] Adequate nutrition and physical activity are needed to achieve optimal growth and maturation. In most normal, healthy infants, growth and maturation progress with few, if any, problems.[5]

Table 8.9 Accurately measuring growth in infants

To Avoid Measurement Errors
• Use measuring equipment that was recently calibrated.
• Confirm that the scale is on zero before starting.
• Weigh the infant nude or wearing a dry diaper.
• Confirm the position of the infant for length measurements: • Head position—the infant's eyes are looking straight up and the head is in midline, touching the head board.   • Neither hips nor knees are bent.   • Heels of feet are flat against the foot board.
• Head circumference measure is at the widest part of the head.

Frequent measurements of weight, length, and head circumference during infancy will facilitate early identification of potential problems such as slow or excessive weight gain or slow linear growth. There is a wide range of appropriate growth patterns in infancy. Healthy infants may have brief periods when their weight gain is slower or more rapid than at other times. Slight variations in growth rate may occur from illness, inappropriate feeding routine, or family disruption. The overall growth pattern is important, and each assessment is compared to the overall health assessment.

Accurate growth measurements and interpretation of growth rates are important components in evaluating an infant's nutritional status. Use of calibrated infant scales, recumbent measuring boards, and non-stretch head circumference tapes improve measurement accuracy.

Standardized methods should be utilized when measuring growth; these techniques require practice and consistency to achieve accuracy. Equipment used to measure infants differs from equipment for measuring older children. The scale bed must be long enough to allow the infant to lie down or sit. Length is measured with the infant recumbent (lying on back) with top of head and bottom of feet touching the measuring board at right angles. Table 8.9 provides strategies to avoid measurement errors.

Positioning the infant quickly and carefully is a skill needed for accurate measurement of recumbent length. Clothing, hair ornaments, and excessive movement of the infant while on the scale or measuring board will affect measurement accuracy. Photo 8.1 shows weight, length, and head circumference measurements obtained with recommended measuring equipment.

Interpretation of Growth Data

A comparison of the World Health Organization (WHO) growth charts and the Centers for Disease Control and Prevention (CDC) growth charts is shown in Table 8.10. Both sets of growth charts show:

- Weight for age
- Length for age
- Weight for length
- Head circumference for age

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Photo 8.1 Infant measurements taken with recumbent length board, digital scale, and head circumference tape.

Table 8.10 Comparison of sample populations used to create the CDC and WHO growth curves for children aged less than 24 months

Characteristic	CDC Growth Reference (2000)	WHO Growth Standards (2006)
Data sources	National vital statistics Missouri and Wisconsin vital statistics (birth lengths) Pediatric Nutrition Surveillance System NHANES I, II, and III	Pelotas, Brazil Accra, Ghana Delhi, India Oslo, Norway Muscat, Oman Davis, California
Type and frequency of data collection	Cross-sectional data on weight and length starting at age 2 months	Longitudinal data with measurements of weight and length at 22 visits
Sample size	4,697 observations for 4,697 distinct children	18,973 observations for 882 distinct children
Exclusion criteria	Very low birthweight (<1,500 g)	Low socioeconomic status Birth at altitude >1,500 m Birth at <37 weeks or ≥42 weeks Perinatal morbidities Child health conditions known to affect growth Maternal smoking during pregnancy or lactation Breastfeeding for <12 months Introduction of complementary foods before age 4 months or after age 6 months Weight-for-length measurements >3 standard deviations above or below median for sex
Breastfeeding among infants in sample	Approximately 50% ever breastfed Approximately 33% breastfeeding at 3 months	100% ever breastfed 100% predominantly breastfeeding at 4 months 100% still breastfeeding at 12 months Complementary foods introduced at mean age of 5.4 months

Source: Use of World Health Organization and CDC Growth Charts for Children Aged 0–59 Months in the United States. Centers for Disease Control and Prevention, *Morbidity and Mortality Weekly Report*, September 10, 2010, Vol. 59, No. RR-9. Available at www.cdc.gov/mmwr.

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The 2006 WHO growth charts include charts for the age range of 0 to 24 months for each gender.[51] The WHO growth charts are based on longitudinal and cross-sectional data of infants who were exclusively or predominantly breastfed, and living in urban, middle-class communities in Brazil, Ghana, Oman, Norway, India, and Davis, California. These growth charts show how infants and children should grow under ideal conditions and environments. The European Society for Pediatric Gastroenterology, Hepatology and Nutrition reported that the patterns of linear growth were remarkably consistent between the different countries and ethnic groups.[52] The CDC and the AAP recommend use of the WHO growth charts for 0 to 24-month-old infants and children. These organizations also recommend use of the 2nd and 98th percentiles on the growth chart curves (these are 2 standard deviations below and above the median) to identify potentially suboptimal growth.[53] Refer to Table 8.10 for a comparison of the CDC and WHO growth charts. Sample WHO growth charts with plotted infant measurements are presented in Chapter 9.

Warning signs of growth difficulties include no increase in weight or length, or a continued decline or rapid increase in weight, length, or head circumference percentile.[17] Head circumference increases are reflective of brain growth.[5] Atypical rates of head circumference growth (notable slowing or rapid increase) will warrant close follow-up by the infant's primary care physician.

8.4 Feeding in Early Infancy

Breast Milk and Formula

The AAP, AND, the Dietary Guidelines for Americans 2020–2025, and Healthy People 2030 Objectives recommend that optimal nutrition for infants be provided by exclusive breastfeeding for the first 6 months of life and continuation of breastfeeding for the second 6 months.[7,29,54,55] Breastfeeding is a key public health strategy for improving infant health and reducing many illnesses, morbidity, and mortality in the first 12 months.[7,17]

The benefits of breastfeeding and composition of breast milk are well described in Chapter 6. Nutrient recommendations for young infants were established based on intakes of exclusively breastfed infants. No additional fluids or foods are needed for infants prior to 4 to 6 months of age.[56,57]

Infant formulas are manufactured to closely resemble human milk; however, there are numerous components that cannot be replicated in commercial formula. Examples include immunoglobulins and lysozyme. Refer to Chapter 6 to review the benefits of breastfeeding and breast milk. In the United States, the manufacturing of infant formula is closely regulated by the Food and Drug Administration (FDA) through the Infant Formula Act of 1980 and its amendments in 1986. In 2014, the FDA updated these quality control and safety regulations to include manufacturer testing of formula products for nutrient composition and presence of any harmful pathogens, and demonstration that their products support normal physical growth in infants.[58] There are frequent changes in formula composition and product lines by manufacturers. There are standard cow milk–based and soy-based infant formulas, and types such as "organic," "**hypoallergenic**," "for spit up or reflux," "reduced lactose," and "follow-up." Table 8.11 lists different types of infant formulas and indications for their use.[59]

Growth and health status of an infant are better indicators of dietary adequacy than the intake of breast milk or formula alone. It is optimal for infants to continue breastfeeding through the first year of life. If breastfeeding is discontinued prior to 1 year of age, infants will need to be transitioned to infant formula. Formula-fed infants need to remain on formula through the first year of life. Routine formulas for full-term infants provide 20 kcal per ounce when prepared as directed. Premature post-discharge formulas provide higher energy, typically at 22 or 24 kcal per ounce. A higher-energy formula may be needed for some infants, such as those with fluid restrictions or increased energy needs.[59]

hypoallergenic Foods or products that have a low risk of promoting food or other allergies.

8.5 Development of Infant Feeding Skills

Infants are born with reflexes that will prepare them to feed successfully. As noted earlier, these reflexes include rooting, sucking, gagging, swallowing, and grasping. To successfully feed, infants need to coordinate sucking, swallowing, and breathing. Infants are also born with food-intake regulation mechanisms that develop over time. In early infancy, self-regulation of feeding is mediated by the pleasure of the sensation of fullness. After the first 4–6 weeks, reflexes fade and infants learn to purposely signal wants and needs. However, it is not until much later—about age 3—when children can verbalize that they are hungry. In between reflexes fading and advancing verbal skills, children's appetites and food intakes are regulated by biological and environmental factors interacting with one another.

Table 8.12 lists the sequence of infant developmental skills and indicators of readiness for feeding. The interaction of biological and environmental factors prevails here, too. Depression in a caregiver may be an underestimated or overlooked variable in an infant's progression with feeding skills. Maternal depression may bring about a lower level of interaction between the parent and

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Table 8.11 Infant formulas: Types and indications for use

Formula Type	Indications for Use	Product Examples
Standard cow milk-based formula	Healthy term infants 0–12 months of age Most commonly used formula	Enfamil Infant Similac Advance Gerber Good Start Gentle Generic store brands
Symptoms of intolerance	Term infants with fussiness or spit up Contains partially hydrolyzed protein and reduced lactose Some have added rice starch	Enfamil Gentlease Similac Sensitive Enfamil A.R. Similac for Spit-Up
Partially hydrolyzed protein	Not considered hypoallergenic Not for use with allergic condition or disease Can be considered for spitting up or fussiness	Gerber Good Start Enfamil Gentlease Similac Total Comfort
Soy-based	Vegetarian diet Galactosemia Hereditary lactase deficiency Not recommended for preterm infants	Enfamil Prosobee Gerber Good Start Soy Similac Soy Isomil Generic store brands
Premature post discharge	For preterm infants transitioning home Higher in energy, protein, and micronutrients than standard term formula Usual concentration: 22 cal/oz but can be mixed to higher concentrations	Enfamil Enfacare Similac Neosure
Extensively hydrolyzed protein	Hypoallergenic Intolerance to cow milk protein, soy protein Significant malabsorption	Gerber Good Start Extensive HA Nutramigen Pregestimil Similac Alimentum
Amino acid based	Multiple food allergies, gastrointestinal tract impairment, malabsorption	Alfamino Infant Elecare for Infants Neocate Infant PurAmino

Source: Adapted from Texas Children's Hospital, *Pediatric Nutrition Reference Guide*, 12th ed., 2019.

Table 8.12 Sequence of infant developmental skills

Age	Mouth Patterns	Hand and Body Skills	Feeding Abilities
Birth–3 months	• Has tongue thrust, rooting, and gag reflex • Begins to babble	• Needs head support • Brings hands to the mouth	• Coordinates the suck-swallow-breathe action while breast- or bottle-feeding
4–7 months	• Transfers food from front to back of the tongue to swallow • Opens the mouth when sees spoon approaching • Begins to control the position of food in the mouth • Uses up-and-down munching movement	• Has head and neck control • Sits with support • Brings objects to the mouth • Begins to sit unaided • Tries to grasp small objects such as toys and food	• Takes a spoonful of pureed/strained food and swallows without choking • Drinks small amounts from cup (with spilling) held by another person • Eats from a spoon easily • Begins to feed self with his or her hands
8–12 months	• Uses the jaw and tongue to mash food • Uses rotary chewing (diagonal movement of the jaw as food is moved to the side or center of the mouth)	• Sits easily unaided • Easily grasps and/or brings small objects to the mouth, such as finger foods • Begins to hold a cup with two hands • Has good eye-hand-mouth coordination	• Begins to eat ground/finely chopped food and small pieces of soft food • Begins to eat less finely chopped food and small pieces of soft, cooked table food • Bites through a variety of textures • Demands to spoon-feed self

Sources: U.S. Department of Agriculture, Infant Nutrition and Feeding: A Guide for Use in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), 2019; Baby Behavior modules, WIC Works Resource system; Holt, K., et al. *Bright Futures: Nutrition*, 3rd ed, 2011; WHO Infant and Young Child Feeding Fact Sheet, 2009.

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infant during feeding, reducing the number or volume of feedings and increasing the risk of slower weight gain.[34] Media influences and changes in social practices also affect how babies are fed. Examples include cultural and ethnic perceptions of breastfeeding, and marketing of infant foods and snack foods.

Several models help assess infant readiness for solid food and spoon feeding. The developmental model is based on identifying infant signs such as movement of the tongue from side to side, good head and trunk control, and ability to sit well with some support. Most infants adapt to a variety of feeding regimens, and various feeding practices can be healthy for them. The parents' ability to read the infant's cues of hunger, satiation, tiredness, disinterest, and discomfort influence feeding-skill progression. The cues infants give may include:

- Watching the food being prepared and anticipation of eating
- Tight fists or reaching for the spoon as a sign of hunger
- Showing displeasure if the feeding pace is too slow or if the feeder temporarily stops
- Starting to play with the food or spoon as satiety sets in
- Slowing the pace of eating, or turning away from food when wanting the feeding to end
- Refusing or spitting out food when they have had enough to eat

Bright Futures Nutrition has developed "Nutrition Questionnaire for Infants," a tool to help identify potential areas of concern[17] The questionnaire is completed by parents and can provide helpful information about the infant–parent feeding experience and dietary intake. It is a useful tool for learning more about a parent's responsiveness to their infant's hunger and satiety cues. Sample questions include:

- How would you describe feeding time with your baby? (always pleasant, usually pleasant, sometimes pleasant, never pleasant)
- How do you know when your baby is hungry or has had enough to eat?

Complementary Feeding and Complementary Foods

Complementary foods are foods and fluids other than breast milk and formula, such as liquids, semi-solid and solid foods consumed in the first year of life.

The purpose of introducing complementary foods is to provide additional energy and nutrients because breast milk alone will no longer provide adequate intakes of energy and most micronutrients after 6 months of age.[56] These foods are fed by spoon to help with the development of the infant's oral-motor and feeding skills. Addition of infant cereal or baby foods to bottles of formula or use of a "feeder" bottle instead of a spoon is not recommended. It provides additional, unnecessary calories and may contribute to rapid weight gain.

Watching a baby learn to eat from a spoon is fun for new parents and caregivers (Photo 8.2). Spoon-feeding is really two new experiences for a baby: a spoon is not soft and warm in the mouth like the breast, and foods offered do not provide the same oral sensation as breast milk or formula. Initially, the baby may try to suck the food from the spoon, and some of the food may spill out of the mouth.

What are considered healthy first foods for infants will vary in different cultures and ethnic groups. Regardless of which foods are offered first, the timing and spacing of new foods can be used to identify any potentially negative reactions. One new food can be offered over a 3- to 5-day period. Commercially prepared baby foods are not a necessity for infants. Parents and caregivers can prepare baby foods at home using a blender or food processor, or by mashing soft foods with a fork. Care must be taken, however, to provide developmentally appropriate textures and to use safe food preparation and storage practices. Addition of salt and sugar to baby food is to be avoided.[29,49,57] The advantage of home-prepared



Coutesy of Gina Nagata

Photo 8.2 Infant showing readiness for next spoonful of food.

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Baby-Led Weaning by Katie Ferraro, M.P.H., R.D.N., C.D.C.E.S.

Baby-led weaning is an alternative to conventional adult-led spoon feeding whereby babies learn to feed themselves wholesome, safe foods offered by parents and caregivers. It is a responsive feeding method that supports the baby's inborn ability and desire to be an active participant in the transition to solid foods.

The baby-led weaning movement was started by Gill Rapley, PhD, a British health visitor and co-author of the original baby-led weaning book, first published in 2008.[61] Rapley advocated for waiting until babies are 6 months of age and are demonstrating the other reliable signs of readiness to eat before starting solid foods. This was in stark contrast to earlier practices that advocated starting solid foods at—or sometimes even before—4 months of age.

In 2003, the World Health Organization changed their infant feeding recommendations to start solid foods at 6 months of age instead of 4.[62] Compared to 4- or 5-month-old babies, 6-month-old babies can sit on their own, safely swallow foods other than infant milk, and are more engaged and active participants in the feeding process, thereby eliminating the need to be spoon-fed by adults.

Benefits of Baby-Led Weaning

While *baby-led weaning* is a relatively new term and parenting phenomenon, the approach and philosophy is millenia old. Different cultures and ethnic groups around the world have historically offered and continue to offer their babies modified versions of the same foods the rest of the family eats. Contrast that with commercial baby food, a largely Western invention that has only been available and marketed since the earlier part of the twentieth century.[63]

With this feeding method, the focus is on allowing the baby to learn *how* to eat, with less emphasis and pressure on *how much* the baby is consuming. The benefits include:[64-66]

- Increased feeding autonomy and participation in family meals from the baby's first bites
- Reduced risk of selective (i.e., "picky") eating later in toddlerhood
- Decreased risk of food allergies due to earlier exposure of potentially allergenic foods

With the baby-led approach, babies learn to recognize and respond to their inborn hunger and satiety cues.

Is Baby-Led Weaning Safe?

Infant milk (breastmilk and/or commercial infant formula) will continue to be a primary source of nutrition during the weaning period. Babies who start solid foods with a baby-led approach are at no higher risk of choking than are conventionally spoon-fed babies, provided parents and caregivers are educated about reducing choking risks.[67–69] Baby-led weaning babies are not at risk for growth faltering, and they are able to meet their overall growth, iron and nutrient needs.[68,70]

Parents and caregivers may be apprehensive about this approach to starting solid foods because it is messy; however, baby-led weaning advocates maintain that learning how to eat is a full sensory experience. Giving babies ample time and experiences to explore food is more important than focusing on how much the baby is eating early on.

Shape and Size of Baby-Led Weaning Foods

From a developmental standpoint, 6-month-old babies can pick up larger pieces of food and safely self-feed. In the earlier part of the weaning period (6–9 months of age), babies use their whole hand or palmar grasp to rake and scoop pieces of food up and into their mouth. Baby-led weaning foods are generally offered as soft pieces of food shaped about the size of an adult pinky finger. Older babies (9–12 months of age) will have developed their pincer grasp which eventually allows them to safely self-feed smaller pieces of food.

This does not mean skipping purees. Purees are an important texture for babies to master; they're just not the only texture babies can eat. Research suggests that babies who have had the least amount of practice with finger foods are at elevated risk of choking.[71]

Families can honor these self-feeding principles and still offer pureed foods such as yogurt or whole grain cereal using the pre-loaded spoon approach. With the pre-loaded spoon approach, the parent or caregiver loads the food on a baby-led weaning spoon and passes it to the baby who learns to self-feed.

baby food is that a wider variety of foods may be offered, including foods from the family diet.

Commercially prepared baby foods are frequently used because they are convenient. Families who pack food for the babysitter or for day care, or who travel with infants often find these foods easy to store and use. Parents and caregivers have a variety of options when purchasing baby foods and snack foods. Selections should be based on the nutritional needs of the infant, and not on the preferences or eating habits of the purchaser.

Baby foods are packaged in jars, plastic containers, and pouches; amounts are often based on manufacturers' standards, not necessarily on recommended serving sizes for infants. Portion sizes should be based on appetite.

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Finishing an entire container or pouch of baby food may foster overeating if parents do not pay attention to satiety cues from their infant.

Many foods eaten by other family members can be appropriate for infants who are 9 to 12 months of age. Examples include unsweetened applesauce; yogurt; soft-cooked vegetables such as sweet potato and broccoli; soft, ripe fruits such as a pear, banana, or watermelon; cooked hot cereal; and oat ring cereal.

Water

Breast milk and formula will generally provide adequate fluid for healthy infants from birth to 6 months of age. No supplemental water is needed at this time.[29,57,60] From 6 to 12 months, up to 4 to 8 ounces of water per day can be offered to infants at mealtimes from a cup.[29,57,60]

The Importance of Infant Feeding Position

Positioning of infants for feedings at the breast or with a bottle and when eating from a spoon is important because improper positioning may be associated with choking and discomfort while eating.[23] Unsafe feeding positions, such as propping a bottle or placing the baby on a pillow, increase the risk for choking, overfeeding, and ear infections. The recommended sleeping position for young infants is lying on the back without elevating the head on a pillow. This position, however, is unsafe and not recommended for feeding.[16]

weaning Gradual process of switching an infant's diet from breast milk and formula to other foods and fluids.

Effective positioning at mealtimes will facilitate successful infant feeding. The infant can achieve good body position and control when provided with support for his head, trunk, and feet. The parent or caregiver offering the spoon can sit directly in front of the infant and make eye contact during the feeding. A high chair is an appropriate feeding chair when the infant can sit without assistance. The infant should be kept in a sitting position with the hips and legs flexed at 90 degrees.

Some healthy infants may show an initial resistance or refusal of complementary foods. These early feeding experiences may be of concern if they persist and contribute to inadequate intakes and slow growth.[72] Case Study 8.1 discusses challenges when a child shows resistance to eating.

Preparing for Drinking from a Cup

The process of **weaning** starts in infancy and is usually completed in toddlerhood. The American Academy of Pediatric Dentistry recommends that parents encourage their infants to drink from a cup as they approach one year of age, and that they transition off the bottle between 12 and 18 months of age.[73] Infants who are exclusively breastfed through the first year can transition to the cup when weaning is desired.

Infants who are not exclusively breastfed, or are breastfed for less than 12 months, need to have fluids from a bottle because their skills in cup drinking are not yet sufficient to meet their fluid needs. Developmental readiness for a cup begins at 6 to 8 months.[23] Eight-month-old infants enjoy trying to mimic drinking from open cups that they see at home. The ability to elevate the tongue and control the liquid emerges later, at closer to a year.

Case Study 8.1 Baby Stella Will Not Eat

Stella is a healthy 8-month-old girl who lives with her mother, Kamila, her father, and her older sister, who is almost three years old. Both parents now work full time, and both children attend day care full time. Kamila nursed Stella exclusively before she returned to work and built up a supply of frozen breast milk. She nurses her twice per day now, early in the morning and before Stella goes to sleep. Stella drinks breast milk from a bottle at day care. The day care staff reports that she is a good baby. However, when Kamila picks her up after work, Stella wants to be held and will not sit in her high chair or eat dinner. She cries if she is not held. Stella's sister wants to eat as soon as they get home. Kamila has so much to do at home after work that she finds it difficult to hold Stella. Kamila thinks that Stella must be hungry and that she would be less irritable if she ate her dinner.

Questions

1. Baby Stella is giving what signs to show that she needs to be comforted rather than fed?
2. How might Kamila change her routine to give baby Stella more attention and meet the needs of her older daughter?
3. Should Kamila stop or continue breastfeeding to improve Stella's eating?



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Robyn Wong

Photo 8.3 Infant drinking water with a straw.

The 10- to 12-month-old infant enjoys drinking from a held cup and trying to hold his own cup, even though the main feeding method is the breast or bottle.

Infants are likely to drink less breast milk or infant formula when served in a cup because they are less efficient with their oral-motor skills. The infant who is weaned too soon may plateau in weight because of decreased volume and associated lower energy intake. Transitioning from the breast or bottle to an open cup or bottle/cup with a straw (Photo 8.3) supports progression of feeding skills and good oral health. At first the typical portion size of fluid from a cup is 1–2 oz, and fluids are offered more often during the day.

Inappropriate and Unsafe Food Choices

Cow Milk The Dietary Guidelines for Americans 2020–2025, the Healthy Eating Research organization and the AAP recommend that infants should not consume cow milk before one year of age.[29,60,74] Iron-deficiency anemia has been linked to early introduction of whole cow's milk. Low iron availability may result from gastrointestinal blood loss or the lack of other iron-rich foods.[75]

Plant-Based Milk Alternatives Plant-based milk alternatives include beverages made from soy, oat, rice, coconut, almond, and hemp. They are not recommended in the first 12 months as a replacement for breast milk or infant formula.[29,49,60] Most of these products are low in energy and low in protein. The protein quality is very low for most of these plant-based milk alternatives, and some contain high amounts of phytate which binds iron, zinc, and calcium. When plant-based milk alternatives were as a major component of an infant's diet, growth faltering and severe protein energy malnutrition were reported.[76]

100% Fruit Juice Juice is not recommended for infants under 12 months of age.[29,60,77] Juice has a high sugar content and this can contribute to increased risk for dental caries.[77] A high intake of fruit juice may reduce intake of more nutrient-dense fluids such as breast milk and formula.

Sugar-Sweetened Beverages The Healthy Eating Research Expert Panel on Healthy Beverage Consumption in Early Childhood has recommended no sugar sweetened beverages (including soda/soft drinks, fruit drinks, fruit-flavored drinks, sports drinks, sweetened water and sweetened tea) for children from birth to 5 years of age.[60] Consumption of sugar-sweetened beverages in early childhood negatively impacts overall health and dietary intake. There is clear and strong evidence that this consumption increases risk for overweight/obesity and dental caries in children and adolescents.[78] Table 8.13—provides recommendations for healthy beverage consumption for infants.[60]

Table 8.13 Summary of key panel findings and recommendations for healthy beverage consumption in early childhood

	0–6 Months	6–12 Months
Plain drinking water	Not needed	0.5-1 cup/day
Plain pasteurized milk	Not recommended	Not recommended
100% fruit juice	Not recommended	Not recommended
Plant milks/Nondairy beverages	Not recommended	Not recommended

Source: Lott, M., et al. Healthy Beverage Consumption in Early Childhood: Recommendations from Key National Health and Nutrition Organizations. Consensus Statement. Durham, NC: Healthy Eating Research, 2019.

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Foods That Can Cause Choking

Some foods are problematic because they increase the risk of choking. Infants accounted for 38 percent of all food-related choking episodes. Formula, cow milk, and breast milk were associated with over one-third of these episodes in infants, with mean occurrence age at 4 months of age. The most common foods associated with choking in infants were fruits, vegetables, biscuits, cookies, and crackers.[79]

Some foods present a choking risk for infants because their chewing skills are emerging and not well developed. Coarse or inappropriate food textures can obstruct the infant's airway because voluntary coughing and clearing of the throat are skills not yet learned. Foods that are small, sticky, slick or hard should also be avoided. Hot dogs, candy, nuts and seeds, raw carrots, grapes, popcorn, and chunks of peanut butter are examples of foods that increase the risk of choking when fed to young children.[29] The AAP Policy Statement on choking in children recommends that young children should be supervised when eating, and that they not lay down with food or a bottle in their mouths.[80]

Recognizing Infants' Hunger and Satiety Cues

Infants depend entirely on their parents and caregivers in learning what, when, and how to eat. Responsive feeding involves a process of reciprocity between the infant and parent or caregiver during feedings. There are three steps to this process:

1. The infant communicates hunger and satiety through motor actions, facial expressions, and/or vocalizations.
2. The parent or caregiver recognizes the infant's cues and responds based on the signal(s) in a manner that is developmentally appropriate and emotionally supportive.

The infant receives predictable responses to his or her signals.

Parental understanding of infant feeding behavior increases as the infant–parent interaction matures from early to late infancy. During early infancy while the sleep/wake cycle of the infant is irregular, it is common for new parents to interpret discomfort as a sign of hunger. The infant's ability to self-calm is a developmental step that plays out differently with different temperaments and parenting styles.[72] Infants who are more sensitive to their environment could seem to be fussy, irritable, or frequently hungry. In contrast, infants who sleep through usual household noises and are less reactive to their environment may be fed less often throughout the day. As a result of varying responses to infant temperament, a pattern of excessive, adequate, or inadequate intakes may result. Parent–infant interaction during early feeding can have long-lasting effects on how parents perceive their child's temperament.[27] In the first few months, the infant's physiological need to suck may easily be confused with hunger by new parents. Typical forward and backward tongue movements with first attempts to eat from a spoon may seem to be a rejection of the food. The infant appears to spit out the food, but this could be a sign of a fading extrusion reflex, learning to swallow, and not necessarily a taste preference. The same food that had appeared to be rejected will be accepted as the infant learns to move the food from the front to the back of the mouth.

Influence of Food Preferences on Feeding Behavior

Infants have been exposed to flavors while in utero. The amniotic fluid and breast milk contain compounds reflective of their mothers' diets.[81] Infants fed breast milk/human milk are exposed to a wider variety of tastes and flavors than infants fed formula.[82] These early experiences initiate the ongoing process of developing food preferences and food habits throughout the life span. Infants have genetic, unlearned preference for sweet and salty tastes, and rejection of sour and bitter tastes.[83]

Food preferences of infants are largely learned, but genetic predisposition toward sweet tastes and against bitter foods are also factors in food preferences. It may take numerous attempts for infants to accept and learn to like new vegetables.[57] There is evidence that young children are more receptive to trying new and different foods when they observe their parents and caregivers eating and enjoying them.[57] Food preferences develop in infancy and begin to set the stage for lifelong eating habits. These dietary habits are not easily changed in adulthood.

8.6 Nutrition Guidance

Nutrition guidance materials and resources for parents and caregivers, and health-care providers are available from many sources, including the Zero to Three: National Center for Infants, Toddlers and Families; the Women, Infants, and Children (WIC) program; and Bright Futures Nutrition.

Zero to Three is a national nonprofit organization that works to ensure that all infants and toddlers have a strong start in life. It develops and promotes resources, tools, and publications for parents, professionals, and policymakers, which enhance the well-being and development in infancy and early childhood.[84]

Infant Nutrition and Feeding: A Guide for Use in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) is a comprehensive, recently updated reference published by the Food and Nutrition Services of the U.S. Department of Agriculture. It is an

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excellent resource for health-care professionals who provide nutrition services to infants, children, and children with special health-care needs.[85] The WIC program also publishes a variety of infant and child-focused nutrition education materials for families and caregivers.

Bright Futures Nutrition provides nutrition and feeding recommendations for parents and caregivers of infants, children, adolescents, and children with special health-care needs. There are also *Bright Futures Nutrition* publications for health-care professionals focusing on anticipatory guidance including key age-related issues and discussion points at well-child visits.

The Infant's Home Environment

Keeping infants healthy at home includes other lifestyle factors along with nutrition. According to the National Institutes of Health Expert Panel on Cardiovascular Health Risks, infants have lower long-term risks if they are breastfed and not exposed to smoking at home.[86] The AAP recommends that infants not be exposed to screen time from televisions, tablets, computers, or similar devices at home or in cars.[87] Although early learning may be the goal, parents' voices and interactions surpass electronic media as a stimulus for language and communication.

Supplements for Infants: Special Circumstances

Specific supplements are recommended for breastfed infants in the United States under certain circumstances:

- Fluoride supplementation is recommended starting at 6 months of age for infants residing in communities with low levels of water fluoridation.[36,38]
- Iron supplementation is recommended for exclusively breastfed term infants starting at 4 months of age at a dose of 1 mg/kg/day, and continued until iron-containing complementary foods are introduced in the diet.[49] Meat as an early complementary food for breastfed infants has been associated with improved iron and zinc status.[1,88]
- Vitamin B_{12} supplementation may be needed for breastfed vegan infants if the maternal diet is inadequate.[89,90] There are no unfortified plant foods that contain significant amounts of the active form of vitamin B_{12}.[91] Fermented soy products are not reliable sources of the active form of this vitamin.[91]

Cross-Cultural Considerations

Cultural beliefs and practices are major influences on the decision and duration to breastfeed, and on what and how infants are fed. Manufactured baby foods are reflective of the American culture and diet. There is little cultural diversity in commercially prepared baby foods. There are a variety of successful avenues for feeding and nourishing healthy infants. Knowledge of cultural models for feeding is highly desirable when counseling families and caregivers at the time when infant feeding and family mealtime routines are being established.

Cultural practices that support the development of competence in parents are encouraged. Some examples of practices that may reflect cultural caregiving practices include swaddling an infant or having an infant sleep in the parent's bed or in a room at a certain temperature. Food patterns may also reflect cultural or religious traditions, and practices based on family traditions may provide social and emotional support for new parents.

8.7 Common Nutritional Issues and Concerns

Some problems occuring in infancy may be related to nutrition; these include colic, diarrhea, and constipation. Less frequent problems include formula or feeding intolerance, iron-deficiency anemia, and food allergies. Tooth eruption begins in infancy; this is the opportune time for families to implement preventative measures to reduce their infant's risk of early childhood caries (ECC).

Infantile Colic

Infantile colic is described as a condition of irritability, and excessive, inconsolable crying in healthy, well-fed infants.[92] It can occur from early infancy up to 4 or 5 months of age, and can have a pattern of onset and duration.[93] The association of colic symptoms, gastrointestinal upset, and infant feeding practices has been studied, but no definitive cause of colic has yet been identified.[94] A 2019 Cochrane Review reported no clear evidence that probiotics were more effective than placebo in the prevention of infantile colic. Daily crying duration, however, appeared to be shorter with probiotic use compared to placebo.[95]

The frequent response to colic in formula-fed infants is to change to another infant formula. The change, however, may not always alter the pattern of colic. Recommendations to relieve colic may include rocking, swaddling, bathing, or utilizing other ways of calming the infant, positioning the baby well during feedings, or burping more frequently. Another intervention previously discussed in Chapter 7 is the elimination of cow milk protein and other food proteins from the diets of breastfeeding mothers.[96]

colic A condition marked by a sudden onset of irritability, fussiness, or crying in a young infant between 2 weeks and 3 months of age who is otherwise growing and healthy.

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Iron Deficiency and Iron-Deficiency Anemia

Iron deficiency is the most common micronutrient deficiency throughout the world.[2] Both iron-deficiency anemia (IDA) and iron deficiency without anemia (ID) during infancy are of major significance because of their relationship with neurodevelopment and behavior.[46] Research in infants who have long-term and severe iron-deficiency anemia suggests inadequate iron contributes to long-term learning delays from its role in central nervous system development.[45] Iron deficiency is associated with poor cognitive, motor, and socio-emotional development in infancy, and in later childhood with poor cognition and school achievement.[3] Risk factors associated with a higher prevalence of IDA include low birthweight, high cow milk intake, low intake of iron-rich complementary foods, low socioeconomic status, and immigrant status.[3]

In the United States, standard infant formulas contain 12 mg of iron per liter. The AI for iron for infants 0–6 months of age is 0.27 mg daily related to adequate iron stores of term infants. After 6 months of age, the iron recommendation increases, with a RDA established at 11 mg per day. Iron deficiency in infants is less common than iron deficiency in toddlers. Infants who have iron deficiency may have other risk factors to their overall development, such as low birthweight, elevated lead levels, or generalized undernutrition. The AAP iron recommendations for treatment of infants with iron deficiency are as follow:[48]

- Iron supplementation is recommended for infants with severe iron-deficiency anemia at a dose of 4–6 mg/kg/day divided into three doses.
- For mild-to-moderate iron deficiency, the recommended dosing is 3 mg/kg/day divided into one to two doses.

Diarrhea and Constipation

Diarrhea is one of the most common illnesses among children in the United States, and 300 to 500 children will die each year from this potentially preventable condition.[97] Approximately 65 percent of the hospitalizations for diarrhea and 8.5 percent of diarrhea-associated deaths occur in the first 12 months of life.[97] Infants with acute diarrhea are at increased risk for dehydration compared to older children because of their higher metabolic rate, smaller fluid reserves, and dependence on others for fluids.[98] Diarrhea is described as the passage of three or more loose, watery stools per day or a stool volume greater than 10 g/kg of body weight in infants.[98,99] The cause of diarrhea during infancy may or may not be identifiable. Diarrhea may result from viral and bacterial infections, food intolerance, or changes in fluid intake.[100] Excessive intake of fruit juice may be a cause of diarrhea in older infants.[101]

The first line of treatment is to continue breastfeeding or feeds of regular strength formula, and to resume an age-appropriate diet, which may include complementary foods. Gut rest is not needed.[98,99] Feeds of an oral rehydration solution are recommended to help replace fluid losses.[98,99] Foods high in simple sugar content are not recommended because the high osmotic load could worsen the diarrhea. Restriction of fat is not recommended; a moderate intake of fat will be beneficial.[102] Vital components of home management of diarrhea are to provide increased volumes of fluids and to maintain adequate energy intakes.[97] Diarrhea can become a serious problem if an infant becomes dehydrated or less responsive; timely medical follow-up is imperative.[97]

Constipation is defined as changes in the frequency, size, consistency, or ease of passing stool.[103] Difficulty with defecation is a common occurrence in infancy and childhood. The problem is often short in duration and of little consequence.[103]

Recommendations for the infant with constipation focus on normal fluid and fiber intakes.[104] If formula fed, assess if formula is mixed correctly. Foods with high dietary fiber content are generally not recommended for infants with constipation because many sources, such as whole-wheat crackers or apples with peels, present a choking hazard.

Fluid Needs During Illness

Fluid needs during illness are of concern because dehydration is a common response to illness in infancy. The infant has limited ability to signal thirst, especially when sick. Vomiting and diarrhea result in dehydration more rapidly in infants than in older children, with symptoms that are more difficult to interpret. Replacement of electrolytes has been the basis for a variety of over-the-counter (OTC) fluid replacement products, such as Pedialyte and generic oral rehydration products. These products contain some glucose (dextrose) along with sodium, potassium, and water. The amount of energy in these products is significantly lower than that contained in breast milk or formula—usually 3 kcal per fluid ounce compared to 20 kcal per fluid ounce in breast milk or formula. These rehydration products are intended for short-term use; prolonged use will result in energy and nutrient deficits.

Early Childhood Caries (ECC)

Early childhood caries are also known as baby bottle caries and baby bottle tooth decay. Feeding practices established in infancy may increase the risk of ECC.

Infants have high oral needs—they love to suck and to explore by putting things in their mouths. They derive comfort from sucking and may relax or fall asleep while sucking. The use of a bottle containing formula, juice, or other sweetened liquid to calm a baby or at bedtime will

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contribute to demineralization of the teeth.[36] The Consensus Statement from the Healthy Eating Research Expert Panel representing the Academy of Nutrition and Dietetics, the American Academy of Pediatric Dentistry, the AAP and the American Heart Association advises that sugar sweetened beverages should not be given to children younger than 5 years of age.[60]

The following measures are recommended by the American Academy of Pediatric Dentistry to decrease the risk of early childhood caries:

- Frequent breastfeeding should be avoided after the first primary tooth begins to erupt and other dietary carbohydrates are introduced.
- Oral hygiene should begin no later than the time the first primary tooth erupts.
- Avoid baby bottle use after 12 to 18 months of age
- Establish a dental routine home no later than 12 months of age. A caries risk assessment should be completed at the first visit.
- Dental and medical providers work collaboratively to ensure all infants and toddlers have access to dental screenings, counseling and preventive measures.[73]

Food Allergies

Infants develop their immune systems over a few years, and while breastfeeding, the mothers' immune system may confer immunological-active compounds to the infant.[105] Infants' gastrointestinal tracts are very sensitive when compared to those of older children, so it is difficult to determine what is food intolerance, sensitization, or a true allergy.[106] However, the prevalence of true food allergies is higher in younger than in older children. About 6–8 percent of children under 4 years of age have allergies that started in infancy.[106,107]

An infant may develop a reaction to the protein in a cow's milk–based formula. Often, such a problem follows a gastrointestinal illness. When the infant is well, protein digestion and absorption occur in groups of two or three amino acids linked together. After an illness, small patches of irritated or inflamed intestinal lining may allow protein fragments of larger lengths of amino acids to be absorbed. Such fragments are hypothesized to trigger a reaction as if a foreign protein had invaded, setting up a local immune or inflammatory response.[106] This absorption of intact protein fragments is the basis for allergic reactions. Recent types of allergy testing are based on measuring precise fractions of antibodies in response to specific triggers so that a sensitized state can be found before a medical emergency occurs. When an infant has reacted to cow's milk protein, it is likely that soy-based formulas will also cause the same allergic reaction.

The most common allergic reactions are respiratory and skin symptoms, such as wheezing or skin rashes.[105] Although food allergies can start in infancy, they are confirmed by specific laboratory tests after infancy.[107] True allergies can present as an array of reactions building up over time, so that it may take several years for the initiating cause to be identified.

Food intolerances are frequently suspected in infants. Families may consider skin rashes, upper airway congestion, diarrhea, and other forms of gastrointestinal upset to be food allergies, but often they are not.[108] The infant with suspected protein intolerance may be changed to a specialized formula composed of **hydrolyzed protein**. Such formulas are expensive and have a taste that older infants may reject. With true food allergies, the protein of a hydrolyzed formula is needed because it will not trigger the same response as intact protein fragments.

Lactose Intolerance

True lactose intolerance is a medical diagnosis that is based on specific gastrointestinal testing for lactase activity. Lactose is a disaccharide comprised of the monosaccharides glucose and galactose. It is the major carbohydrate in the diets of young infants.[109] The digestive enzyme lactase is located in the brush border of the small intestine, and hydrolyzes lactose into glucose and galactose.

Symptoms of lactose intolerance include abdominal distension, flatulence, abdominal cramping, and diarrhea. These symptoms are independent of the cause of lactose malabsorption, and are directly related to the quantity of lactose ingested.[109]

Infants born before 34 weeks gestation have immature gastrointestinal tracts and lactase and other disaccharidases are deficient.[110] By 34 weeks gestation, the infant's lactase activity is only 30 percent that of term infants.[110]

Gastrointestinal infections may temporarily cause lactose intolerance in infants because the irritated area of the intestine affects the digestion of lactose.[110] The ability to digest lactose generally returns shortly after the illness subsides. Use of formulas containing lactose and human milk did not appear to have any short-term or long-term deleterious effects in preterm infants.[111]

Lactose is present in all dairy products, including cow milk–based infant formulas. The use of lactose-containing formulas and human milk with preterm infants has not been associated with short or long-term adverse effects in these preterm infants. Lactose-reduced infant formulas are options for term infants; additional carbohydrates are provided by other sources, such as modified cornstarch or sucrose.

hydrolyzed protein formula Formula that contains enzymatically digested protein, or single amino acids, rather than protein as it naturally occurs in foods.

lactose A form of sugar or carbohydrate composed of galactose and glucose.

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Table 8.14 Summary of Addendum Guidelines for the Prevention of Peanut Allergy in the United States[114]

Addendum Guidelines	Infant Criteria	Recommendations	Earliest Age of Peanut Introduction
1	Severe eczema, egg allergy, or both	Strongly consider evaluation by specific IgE measurement and/or skin prick test, and, if necessary, an oral food challenge. Based on test results, introduce peanut-containing foods.	4–6 months
2	Mild-to-moderate eczema	Introduce peanut-containing foods	Around 6 months
3	No eczema or any food allergy	Introduce peanut-containing foods	Age appropriate and in accordance with family preferences and cultural practices

Peanut Allergy

In the United States, a peanut allergy is the leading cause of death related to food-induced anaphylaxis.[112,113] The overall mortality rate is low; however, the anxiety and fear of life-threatening anaphylactic reactions contribute significantly to medical and psychosocial burdens of disease.[114] The Learning Early about Peanut Allergy (LEAP) trial was the first randomized trial studying early allergen introduction as a preventive strategy. The landmark finding of the LEAP trial was that introduction of peanut products in the diets of infants at high risk of developing peanut allergy was safe, and shown to reduce the prevalence of peanut allergy.[115] An expert panel was convened by the National Institute of Allergy and Infectious Diseases (NIAID), and panel participants developed an *Addendum Guidelines for the Prevention of Peanut Allergy in the United States*.[114] *These guidelines detail* a three-pronged approach for the introduction of peanuts to infants on the basis of the level of their risk for peanut allergy, and have been endorsed by the American Academy of Pediatrics. Refer to Table 8.14.

Vegetarian and Vegan Diets

Vegetarian diets can support normal growth and development in infants when well designed to meet nutritional needs in the first year.[28,89,90,117,118] The more restrictive the diet and the younger the age of the child are factors that increase risk for nutrient deficiencies and supplementation may be needed.[118] Nutrients requiring this attention include protein, essential fatty acids, iron, zinc, calcium, vitamin B_{12} and vitamin D.[118,119] Vegetarian mothers are encouraged to breastfeed. If formula is needed, soy-based infant formula is an appropriate option for vegan infants.[120]

The docosahexaenoic acid (DHA) content in breast milk is lower in vegetarian mothers than nonvegetarian mothers.[121] DHA is important in infancy because of its role in neurological and visual development.[33] Because of this, DHA-fortified foods are recommended in the maternal diet, or a daily DHA supplement can be provided to these infants. Poorly nourished mothers or those on vegan diets may require supplementation of DHA and multivitamins.[54]

Food Allergy Considerations for Infants and Toddlers

There is no need for pregnant or breastfeeding women to avoid consuming common allergenic food items such as eggs, milk, peanuts, tree nuts, fish, shellfish, and wheat. Doing so does not help lower the risk of food allergies in children.[116]

If the biological parent has allergies to any food items, talk to the child's doctor about any precautions regarding the introduction of common allergenic food items (such as products with peanuts, egg, dairy, or wheat) to the infant.

Ask the child's doctor if considering using hydrolyzed or "hypoallergenic" infant formulas as these formulas have not been found to help prevent food allergies in infants.

Common allergenic food items can be introduced to the baby when she/he is ready to eat solid food (usually between 4 and 6 months of age). These food items include dairy products such as yogurt, eggs, soy, wheat, peanut butter, fish, and shellfish.

Introduce common allergenic food items to the child after other solid food has been fed and tolerated, and with the first taste being at home. If no reaction occurs, then gradually increase the amount at a rate of one new food every 3 to 5 days.

There is no need to avoid acidic food for the child, such as berries, tomatoes, citrus fruits, and vegetables, that may cause a rash around the mouth or buttocks. The rash is the result of irritation from the acid in the food, not from an allergic reaction to the food.

Some infants and toddlers do develop food allergies. If the infant or toddler develops signs of a food allergy (e.g., skin rashes, trouble breathing, nausea, vomiting, or loose stools in response to feeding) seek medical care and advice right away. Referral to an allergist/immunologist, a doctor with experience in food allergy, may be used for further evaluation.

The doctor may recommend a comprehensive evaluation and the development of a personalized plan to introduce solid food to the infant.

Sources: Guidelines adapted from American Academy of Allergy, Asthma & Immunology (2015); and Australasian Society of Clinical Immunology and Allergy (2016).[57]

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8.8 Nutrition Intervention for Risk Reduction

Primary Prevention of Obesity During Infancy

Pediatric health-care providers have key roles and timely opportunities in the prevention of obesity in infancy. Closer attention to growth patterns in early childhood is vital; identifying rapid weight velocities and upward crossing of percentile channels are associated with overweight and obesity in later life. Achieving healthy behaviors early on can have long-lasting benefits. Strategies focus on breastfeeding and self-regulation of intake—feeding infants when they are hungry instead of on a set schedule, providing age-specific guidelines for formula per feeding and appropriate portion sizes for infants, adequate sleep duration, and parental regulation as a critical component in the development of children's overall self-regulation skills.[122]

Model Programs

Early Head Start Early Head Start is a federally funded program that provides early, continuous, intensive, and comprehensive child development and family support services to low-income infants and toddlers and their families. Early Head Start programs provide similar services as preschool Head Start programs, but are geared to meet the needs of infants and toddlers. Snacks and mealtimes are used as learning opportunities. Family style meals are encouraged when developmentally appropriate.[123]

Newborn Screening Over 3.7 million infants were born in the United States in 2019.[8] Nearly all of these infants were screened soon after birth for at least 29 health conditions. The Centers for Disease Control reported that approximately 12,500 newborns are diagnosed with one or more health condition through newborn screening. The five most commonly diagnosed conditions in the United States are: (1) hearing loss, (2) primary congenital hypothyroidism, (3) cystic fibrosis, (4) sickle cell disease, and (5) medium-chain acyl-CoA dehydrogenase deficiency.[124]

Other conditions in the newborn screening panel include various inherited metabolic diseases, some requiring therapeutic diets, specialty formulas or "medical foods," supplements, and/or medications. Food and nutrient modifications are implemented to avoid or reduce the offending component(s) involved in the affected metabolic pathway. Registered dietitian-nutritionists are members on specialty metabolic teams that provide medical treatment and nutritional management of individuals with inherited metabolic diseases.

Key Points

1. Infancy is a unique time when feeding skills and eating behaviors are emerging. It is an opportune time for families and caregivers to foster healthy eating and mealtime behaviors.
2. Parents' ability to read their infant's signals of readiness, hunger, and satiety promote successful feeding relationships and development of healthy eating habits.
3. Nutrition assessments in infancy often include a review of dietary intakes of vitamin D, iron, and fluoride. These micronutrients may require supplementation to achieve recommended levels.
4. Rates of linear growth and weight gain occur more rapidly in the first year of life than at any other time in the life cycle. Frequent weight, length, and head circumference measurements are needed to assess adequacy of growth in infancy.
5. Common nutrition problems in the first year such as colic, diarrhea, constipation, regurgitation, and spit-up may be resolved with parental education, dietary interventions, and medical approaches.
6. Infant feeding can embrace varied cultural and parenting styles, ethnic foods, and cultural feeding practices.

Review Questions

1. Which is a **true** statement about limiting nutrients in infancy?
   a. Iron supplementation is initiated when infants are 6 months of age.
   b. Vitamin D supplementation is needed in breastfed infants because the content is low in breast milk/human milk.
   c. Low intake of dietary fiber is a common cause of constipation in infants.
   d. Fluoride is not needed until teeth start erupting in late infancy.
2. What is a **true** statement about newborn infants?
   a. The large-for-gestational-age infant is born at or after 42 weeks' gestation.
   b. The newborn rooting reflex may interfere with an infant's ability to bottle feed.
   c. Newborn reflexes promote the coordination of feeding and breathing.
   d. The ability to sit is achieved with the help of newborn reflexes.

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3. Which meal carries the lowest choking risk for a 9-month-old infant?
   a. Scrambled egg, slice of sausage, buttered toast pieces
   b. Vegetable and chicken dinner, soda cracker, apple slice
   c. Chicken nuggets, mashed potatoes, grapes
   d. Cooked carrot, applesauce, beef and macaroni dinner
4. Which statement about the digestive system during infancy is **true**?
   a. Gastrointestinal problems frequently interfere with health and growth in young infants.
   b. The GI tract is completely functional for digestion at 9–12 months of age.
   c. Infant stools change based on the ability of the intestinal villi to absorb nutrients.
5. Which is a **true** statement concerning fats?
   a. Infants need a higher percentage of their daily calories from fat than children and adults.
   b. Breast milk is lower in fat than standard infant formulas.
   c. Long-chain fatty acids are not needed for healthy infants in the first year.
   d. Fat restriction can be initiated in the first year for infants who were born at term.
6. What is a disadvantage of feeding a larger volume of formula or breast milk than recommended? _____ (short answer)
7. Which of the following statements is **true**?
   a. Formula-fed infants are ready for complementary foods after 6 months of age.
   b. A delayed introduction of solid foods is recommended for infants with a family history of food allergies.
   c. Complementary foods high in iron and zinc are recommended for breastfed infants.
   d. Use of commercially prepared baby foods can reduce the risk of food allergy.
8. A 3-month-old infant is growing well but not sleeping through the night. Her mother thinks he may be sick because he cries so much. What is a possible explanation for an infant not sleeping through the night?
   a. The infant is ready for the introduction of complementary foods.
   b. A maternal restriction of dairy foods may help reduce gastrointestinal upset.
   c. A change in infant formula will improve feeding tolerance.
   d. Increasing the frequency or duration of breastfeeding will provide more satiety.
9. Describe four strategies that parents and caregivers can implement to foster healthy eating behaviors starting in infancy. _____
   _____
   _____
   _____

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9

Infant Nutrition

Conditions and Interventions

Prepared by Robyn Wong

Learning Objectives

After studying the materials in this chapter, you should be able to:

9.1 Describe factors that put infants at nutritional risk and how nutritional assessment and interventions address these risks.

9.2 Compare the energy and nutrition needs of preterm infants, infants with special health-care needs, and healthy full-term infants.

9.3 Describe how the growth of preterm infants and infants with special health needs is tracked and interpreted.

9.4 Identify nutrition problems that are more frequently identified in preterm infants and infants with special health-care needs.

9.5 Provide examples of nutrition assessment and interventions for infants with special health-care needs and chronic illness.

9.6 Identify appropriate nutrition intervention strategies for infants with slow linear growth or weight gain.

9.7 Describe how families of high-risk infants and infants with special health-care needs access nutrition resources and services in their communities.

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Introduction

Most infants are born healthy and then achieve normal growth and development in the first year of life. These infants may experience minor illnesses that do not adversely affect their growth, development, and overall health status.

Infants who are born prematurely, have special health-care needs, or **developmental delay**, are at increased risk for compromised nutritional status and altered growth.[1] Children and youth with special health-care needs (CYSHCN) is defined as "those who have or are at risk for chronic physical, developmental, behavioral, or emotional conditions. In addition they require health and related services of a type or amount beyond that required by children generally."[2] Infants are included in this population.

Up to 40 percent of infants and children with special health-care needs were found to be at nutritional risk,[3] while 79–90 percent of infants and children from birth to 3 years of age with developmental delays were found to have one or more nutritional risk factors.[4] Indicators of nutritional risk include altered growth, increased or decreased energy needs, drug–nutrient interactions, metabolic disorders, impaired nutrient utilization, poor feeding skills, and use of partial or exclusive enteral or parenteral nutrition.[3] This chapter discusses some of the common nutritional concerns of preterm infants, infants with special health-care needs, and/or developmental delay.

9.1 Infants at Risk

The number of infants needing nutritional services is increasing in large measure because of advances in perinatal and neonatal intensive care. Increased survival and reduced long-term morbidity in preterm infants have occurred; most notably in **extremely low-birthweight (ELBW)** infants and **very low-birthweight (VLBW)** infants.[5] **Low-birthweight (LBW) infants** weigh less than 2500 grams at birth. Individualized nutritional care is vital for ELBW, VLBW and LBW infants because of the notable variability in their medical conditions, physiological development, and feeding tolerance.[5]

developmental delay Slow to meet or not reaching milestones expected for a child's age in one or more areas of development: communication, motor, cognition, social-emotional, or adaptive skills.

extremely low-birthweight infant (ELBW) An infant weighing less than 1000 grams at birth.

very low-birthweight infant (VLBW) An infant weighing less than 1500 grams at birth.

low-birthweight infant (LBW) An infant weighing less than 2500 grams at birth.

Down syndrome or Trisomy 21 this is a condition in which three copies of chromosome 21 occur. It may be associated with low muscle tone (hypotonia), short stature, feeding difficulty and risk of overweight.

The infant mortality rate for low birth weight decreased from 91.9 per 100,000 live births in 2019 to 86.9 per 100,000 live births in 2020. This was a 5.4 percent reduction in 1 year.[6]

Health outcome measures provide a more comprehensive view of the impact of preterm birth and illness than infant mortality rates alone. Preterm infants, infants with genetic disorders, malformations, or birth complications have benefited from advances in medical care; however, they are at increased risk for chronic conditions, and need for medical care and services as they grow older. Health outcome measures can be used to assess longitudinal growth, health problems, functional limitations, and utilization of health-care and other resources.[7,8] Their nutritional needs can differ from those of full-term infants, sometimes well past infancy.[3,4]

Term infants are born at or after 37 weeks gestation. Late preterm infants are born between 34 to $36^{6}/_{7}$ weeks gestation and have higher incidence of temperature instability, respiratory distress, hyperbilirubinemia, hypoglycemia, feeding problems, and rehospitalization than term infants. Late preterm infants may have more difficulty with establishing breastfeeding/chestfeeding and have immature gastrointestinal function. More attention is being given to the medical needs and developmental issues of this population of infants.[9,10]

Regardless of what condition is involved, the following nutrition questions may be helpful:[11]

- How often does your baby feed? How long does a feeding generally take?
- How does your baby behave during a feeding? Pulls away, arches back, looks irritable or calm?
- How does your baby behave after feedings? Satisfied, still hungry, anxious?
- Has your baby had any other fluids from a bottle?
- How many wet diapers and stools does your baby have every day?

In-depth nutrition assessments are completed to determine adequacy of energy and nutrient intakes in supporting optimal growth and development. Such assessments are important for the following infants:

- *Infants born before 34 weeks gestation.* These infants have inadequate nutrient stores, increased nutritional demands, immature gastrointestinal function, and altered feeding patterns.[12]
- *Infants affected by abnormal development in utero.* These include infants with cardiac malformations, exposure to drugs, alcohol or tobacco, or genetic conditions such as Trisomy 21, also known as **Down syndrome**.

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- *Infants at risk for chronic health problems*. Risks may come from the treatment needed to save their lives, or from the home environment. Some examples of conditions that increase nutritional risk are **seizures**, cystic fibrosis, and fetal alcohol syndrome. Long-term outcomes, such as learning, attention, and behavioral problems, may not be known for years.

Families of Infants with Special Health-Care Needs

Every parent's wish is that his or her baby will be healthy. When parents find out their newborn has medical problems, they may grieve for the loss of the perfect child of their dreams. The emotional impact of having a sick newborn may overwhelm many parents, and health-care providers need to be sensitive to parents' emotional needs. Coping styles of family members will vary, even if they are well prepared for the diagnosis. It may take time for some family members to comprehend how their baby is doing and to adjust to the special needs of their infant.

9.2 Energy and Nutrient Needs of Preterm Infants and Infants with Special Health-Care Needs and/or Developmental Delay

Nutrient and energy requirements for preterm and high-risk infants are generally based on recommendations for healthy infants.[13] Specific nutrient needs may be higher or lower based on the medical or health condition involved. Adjusting the nutrition care plan and close monitoring of growth and development are needed in the first year.

Energy Needs

When assessing energy needs of infants with special health-care needs, use of the Recommended Daily Allowance (RDA) may not be appropriate, as the RDA is based solely on age. The revised Daily Reference Intake (DRI) for energy—the Estimated Energy Requirements (EER)—may be more accurate in predicting the energy needs of infants with special health-care needs.[14] The EER for infants uses predictive equations that account for total energy expenditure and energy deposition, which includes a calculation for growth depending on the age of the infant/toddler. There are three EER age-group categories in infancy: 0–2.99 months, 3–5.99 months, and 6 months to 2.99 years (Table 9.1).[15,16]

Energy needs may be the same as, lower than or higher than the EER for age. For infants with cleft lip and/or cleft palate, or phenylketonuria (PKU), use of the EER for energy will be appropriate. Infants who frequently need higher energy intakes include preterm infants, infants with congenital heart disease, and infants with bronchopulmonary dysplasia. Some infants need lower energy intakes related to reduced activity and energy expenditure, lower basal energy needs, or slower rates of growth. This may include infants with Down syndrome and spina bifida.[17] Excess energy for these infants may contribute to overweight and could affect their growth and development.

Estimated energy requirements can change related to medication use, activity level, health status, and growth velocity. Additional energy may be indicated in circumstances such as:

- Infection
- Fever
- Difficulty breathing
- Temperature regulation
- Recovery from surgery

Very low-birthweight (VLBW) infants are infants weighing less than 1,500 grams at birth. The American Academy of Pediatrics recommends that premature infants need 110–130 kcal per kg[13] while the European Society

seizures Condition in which electrical nerve transmission in the brain is disrupted, resulting in periods of loss of function that vary in severity.

Table 9.1 Summary table of EER equations by age, sex, physical activity, and energy cost of growth: Children and adolescents

Age Group	Sex	PAL Category	EER Equation (kcal/d)
0 to 2.99 months	M	–	EER = −716.45 − (1.00 × age) + (17.82 × height) + (15.06 × weight) + 200
	F	–	EER = −69.15 + (80.0 × age) + (2.65 × height) + (54.15 × weight) + 180
3 to 5.99 months	M	–	EER = −716.45 − (1.00 × age) + (17.82 × height) + (15.06 × weight) + 50
	F	–	EER = −69.15 + (80.0 × age) + (2.65 × height) + (54.15 × weight) + 60
6 months to 2.99 years	M	–	EER = −716.45 − (1.00 × age) + (17.82 × height) + (15.06 × weight) + 20
	F	–	EER = −69.15 + (80.0 × age) + (2.65 × height) + (54.15 × weight) + 20/15[a]

Notes: kcal/d = kilocalories per day; PAL = physical activity level; EER = Estimated Energy Requirement. Age is in years, weight is in kilograms, and height is in centimeters.

[a]Energy cost of growth for girls: 6 to 11.99 months: 20 kcal/d; 12 to 35.99 months: 15 kcal/d.

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Robyn Wong

Photo 9.1 A former extremely low birth weight infant with bronchopulmonary dysplasia who was discharged home on oxygen support.

for Gastroenterology and Nutrition recommends a similar energy intake of 110–135 kcal/kg.[18] Intakes for recovering premature infants may be even higher, and the range of energy needs can be wide.

Photo 9.1 shows a former extremely low birth weight infant who was discharged home on oxygen support and a higher energy-higher protein formula.

Protein Requirements

As with energy needs, protein requirements of infants with special health-care needs may be the same as, less than, or greater than those of other infants. In the first 6 months of life, the DRI for protein is 1.52 g per kg body weight. It declines to 1.2 g per kg from 7 to 12 months of age.

Conditions that could slow growth velocity may require protein intakes above the DRI. Higher protein intakes are recommended for preterm infants; for micropreterm infants born before 30 weeks gestation, this recommendation may be as high as 4.5 g per kg body weight.[19] The importance of protein for growing neonates is hard to overemphasize. Protein is needed to develop the structural scaffolding for the brain, and it supports linear growth. It provides the building blocks for signaling molecules including growth factors and neurotransmitters, which have an influential role in cognition.[20] Linear growth in the first year of life, independent of weight gain, influences later cognitive and language development in preterm and term infants.[21,22]

Because of increased catabolism during trauma and surgery, provision of optimal protein is required. This quantity of protein is disease or condition-specific and needs to be individualized.[23] Protein requirements are also higher in infants needing to achieve **catch-up growth**.[24]

Protein recommendations lower than the DRI are unusual in infancy. Some inherited metabolic disorders such as phenylketonuria can affect protein metabolism. Treatment of some inherited metabolic disorders may require a restriction or reduction in dietary protein or in certain amino acids, and monitoring of blood levels of certain amino acids.

catch-up growth The accelerated growth that occurs following a period of restricted or slow growth.

Forms of Protein

Many illnesses interfere with the functioning of the gastrointestinal tract and digestion, even for term infants born with intact enzymes for protein digestion. Protein and fat digestion depend on liver and pancreatic enzymes for intestinal absorption. Sick infants may require partially or extensively hydrolyzed protein or amino acid–based formulas. Use of modified protein and amino acid infant formulas may also be indicated with cow milk protein allergy, multiple food protein intolerance,[25] and in the medical management of inherited metabolic disorders related to nitrogen metabolism.[26]

Fat

An adequate fat intake is essential to support the rapid growth and development and high-energy requirements in infancy.[27] Compared to children and adults, infants need a higher percentage of their daily calories from fat. Fat provides 45–55 percent of the energy content in human milk.[28] Low-fat diets and restriction of fat are not recommended for infants. Conditions that require limiting fats for infants are very rare. Fats are more difficult for preterm infants to digest and absorb related to a reduced secretion of pancreatic and liver enzymes.[29] Medium-chain triglycerides do not require bile for absorption and are a routine source of fat in preterm infant formula.

Vitamins and Minerals

DRIs of vitamins and minerals for infants were established to meet the nutrient requirements of nearly all healthy and well infants. These recommendations are also generally applicable for most infants with special health-care needs. Vitamin and mineral requirements may be affected by various health conditions, particularly those involving the gastrointestinal tract. Certain medications may decrease

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or impair nutrient absorption or increase excretion.[30] The treatment for some inherited metabolic disorders may require micronutrient supplementation well above the DRI for age and periodic assessment for nutrient deficiencies.[31]

The American Academy of Pediatrics has addressed the higher iron needs of preterm infants. For preterm infants fed human milk, the AAP recommends an iron intake of at least 2 mg/kg/day. Preterm infants who are formula fed may need additional iron supplementation, while full-term infants obtain adequate iron from their infant formula.[32]

Some infants with special health-care needs have fluid restrictions that result in a reduced feeding volume; this results in a reduction in micronutrient intakes. Higher caloric density formulas may be needed to achieve more optimal macro and micronutrient intakes. Infants with cystic fibrosis (CF) may continue to have problems with fat malabsorption and this affects absorption of the fat-soluble vitamins A, D, E, and K. Fat-soluble vitamin supplementation at levels above the DRI for age are recommended and there are CF-specific multivitamin supplements available.[33]

Human milk fortifiers are routinely used in neonatal intensive care units to increase the energy, protein and micronutrient content of breast milk. The human milk fortifiers used in the United States are made from human milk and from bovine milk. The protein and micronutrient content of these human milk fortifier products vary. Key nutrients for preterm infants include protein, calcium, phosphorus, magnesium, sodium, potassium, chloride, zinc, and copper.[34] Variable amounts of iron are contained in human milk fortifiers; the quantities are not sufficient to meet the higher iron needs of preterm infants. Additional iron will be needed for infants on fortified human milk feedings.

9.3 Growth of Infants at Risk or with Special Health-Care Needs

Growth in infancy is usually a reassuring sign that sufficient energy and nutrients are being provided. Sometimes slow growth is a symptom of an underlying condition, rather than a sign of inadequate nutrition. For example, some infants who are born with chromosomal disorders may be small for their age although they are consuming adequate nutrients and energy during the first year.

Modifications in the usual methods of measuring and interpreting growth are needed in conditions known to influence growth and development:

- Using specialty growth charts for preterm infants, and specialty growth charts for infants with conditions such as Down syndrome and Prader-Willi syndrome. A list of specialty growth charts is included in Chapter 13.
- Using corrected age when assessing former preterm infants' growth and weight gain.
- Obtaining additional anthropometric measurements to better assess body composition, such as mid-arm circumference and triceps skinfold.
- Close monitoring of head circumference in the first year when the brain is rapidly growing. There is a high risk of growth failure in children with **developmental disabilities**; this can be seen with slower incremental increases in weight, length, or head circumference.[14]
- Using available evidence-based practice treatment guidelines and published protocols for conditions such as cystic fibrosis and inherited metabolic disorders.
- Assessing medications that may affect weight gain, appetite, or body composition. Side effects of medications can also affect weight status.

Growth in Preterm Infants

There are a variety of growth charts used to assess and monitor preterm infants; these were developed based on growth data of different populations of preterm infants. The Fenton preterm infant growth charts are based on a sample size of almost 4 million infants at birth using population-based surveys in Germany, the United States, Italy, Australia, Scotland, and Canada. These growth charts are gender specific and provide weight, length, and head circumference percentiles from 23 to 40 weeks gestation. The Fenton growth data and the World Health Organization (WHO) growth curves for term infants were smoothed to extend from 40 to 50 weeks **postmenstrual age**, which is the equivalent of term to 2½ months corrected age.[35] The Olsen intrauterine growth charts are based on a sample size of more than 250,000 infants born in the United States. These charts are also gender specific. They provide intrauterine growth data from 23 to 50 weeks postmenstrual age.[36]

Olsen et al. published gender-specific reference curves to track the body mass index (BMI) changes in preterm infants. These BMI curves were developed utilizing data of the same population of racially diverse infants. There have not been tools available to assess appropriate weight for length in preterm infants prior to the release of these BMI curves.[37]

An important consideration when using the Fenton and Olsen preterm growth charts is that they reflect cross-sectional birth data. They are not reflective of the

developmental disabilities A group of conditions due to an impairment in physical, learning, language, or behavioral areas. These conditions have onset in the developmental period, may impact daily functioning, and usually last throughout a person's lifetime.

postmenstrual age The gestational age plus the chronological age, usually reported in weeks. This is the preferred term during the neonate's time in the hospital. For example, an infant born at 30 weeks who is now 4 weeks old has a postmenstrual age of 34 weeks.

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longitudinal postnatal growth actually achieved by preterm infants. Nutrient intakes of very low birthweight and extremely low-birthweight infants are much lower than intakes received *in utero* by the fetus. These nutritional deficits often continue throughout the duration of their hospitalization.[38] There are concepts that impact how growth is assessed regardless of which specialty growth chart is being used. The body composition of preterm infants is not the same as that of term infants because these infants may have missed part of the second and/or third trimester. Body fat accretion occurs in the third trimester. In addition to low fat stores, they have low stores of glycogen, protein, fat-soluble vitamins, calcium, phosphorus, and trace minerals.[39] Treatment of an infant's medical condition may also affect growth assessment; for instance, fluid accumulation may artificially increase weight.

Extremely low-birthweight infants (weighing less than 1000 grams at birth) with higher growth velocity rates during their hospitalization were found to have better neurodevelopmental and growth outcomes at 18–22 months corrected age.[8] As the rate of weight gain increased, the incidence of cerebral palsy, low developmental index scores, and abnormal neurological exam declined. Slower weight gain and head circumference growth velocity were associated with increased likelihood of suboptimal growth, below the 10th percentile at 18–22 months corrected age.[8]

Corrected Age

Corrected age is the age of a former premature infant calculated by subtracting the number of weeks or months born prematurely from the current chronological age. For example, a 12 month old who was born 3 months early has a corrected age of 9 months. The corrected age of 9 months would be used in plotting the growth measurements taken at the 1-year clinic visit. Figure 9.1 shows the growth of a girl born at 32 weeks gestation using the WHO growth charts and her chronological and corrected ages. The blue plots are her measurements using chronological age; the red plots use her corrected age. Use of corrected age is preferred when assessing the growth of former preterm infants. Her weight, length, and head circumference progressed appropriately and catch up growth was noted. Her weight was in good proportion to her length; she was not overweight or underweight. This was illustrated by weight-for-length percentiles that progressed along the 25th to 50th percentile.

Photo 9.2 shows a former VLBW infant during a follow up nutrition visit. At that time, he was growing and gaining well. All growth measurements plotted above the 25th percentile for his corrected age.

corrected age Chronological (actual) age minus the number of weeks or months the infant was born premature.



Robyn Wong

Photo 9.2 A former very low birthweight infant growing and gaining well in his first year.

Does Intrauterine Growth Predict Extrauterine Growth?

Research shows that some infants were born prematurely due to conditions originating during the intrauterine period.[40] Infants with intrauterine growth restriction (IUGR) are at increased risk for metabolic disturbances related to fatty acid and glucose metabolism.[41] The abnormal fetal growth pattern may persist despite adequate medical and nutrition support after birth.

Other factors associated with IUGR include genetic factors, congenital anomalies, infection, multiple gestation, maternal nutrition, environmental toxins including cigarette smoking, excess alcohol ingestion and illicit drug use, placental factors and maternal vascular disease including diabetes, chronic hypertension, advanced maternal age, and morbid obesity.[42] There are known associations between birthweight below the 10th percentile (SGA) and later development of hypertension, hypercholesterolemia, coronary heart disease, impaired glucose tolerance, and diabetes.[42]

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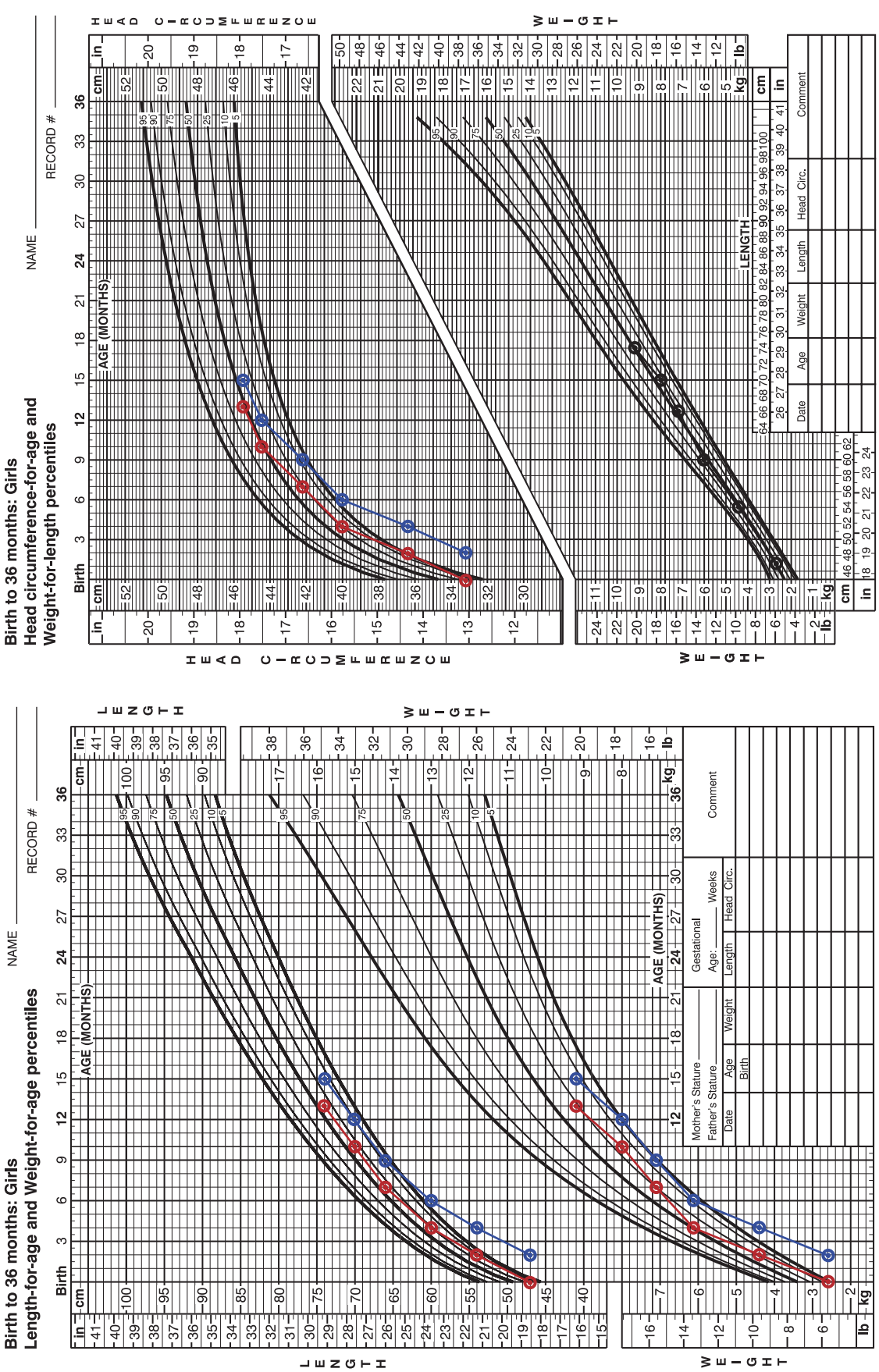


Figure 9.1 WHO growth charts showing a girl born at 32 weeks gestation (8 weeks early). Red plots are measurements based on her chronological age. The blue plots show her growth and weight gain based on corrected age.

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Intrauterine growth may not predict postnatal growth for some infants whose birth removes them from adverse exposure within the intrauterine environment. Examples include uncontrolled maternal diabetes, smoking or drug exposure, maternal phenylketonuria, or maternal seizures treated with medications. In such cases, the rate of growth after birth may improve after delivery and in the first year.

There is evidence that supports a hypothesis called *fetal programming*, or fetal origins of adult disease. This hypothesis proposes that what happens in early life during critical or sensitive periods can have lifetime consequences.[43] Many studies on the outcome of preterm birth, including those on feeding, growth, and types of nutrition, support the fetal programming hypothesis. Preterm birth has been correlated with lifelong impacts on measures such as school performance, dropout rate, adult size, adult chronic diseases, and mental health status.[44,45] Poor head circumference growth in neonates was associated with abnormal neurological exam, abnormal mobility at 5.4 years of age, higher incidence of cerebral palsy, and neurological impairment.[46]

The fetal origins hypothesis can explain why medical treatment may not change the rate of early growth. Preterm birth or its complications may contribute to slow growth early in infancy. Various studies that have measured recovery from early growth problems have found that several factors can overwhelm nutrition benefits.[44-46]

More aggressive feeding and nutritional management practices for infants continue to be implemented; however, postnatal growth failure may continue.[8,47] Growth outcomes after preterm birth can be impacted by a wide range of medical conditions, such as respiratory problems. Catch-up growth may be achieved during recovery in many infants, resulting in improved growth patterns. Surgery required for cardiac conditions may alter growth for a brief period. Close monitoring over time may identify signs of early catch-up growth, such as an increase in fat stores or length velocity.[48] Rapid rates of growth in preterm infants, however, may increase risk for later chronic conditions, such as cardiovascular disease and diabetes, if the rate of weight gain is excessive.[48,49]

Interpretation of Growth

A growth rate of 15 to 20 g/kg per day is needed for preterm infants up to 2,000 g. For preterm infants over 2,000 g, a rate of 20 to 30 g per day is recommended.[50] Strong emphasis is placed on growth as a sign of improving health in small and sick infants after discharge, but complications may make this difficult to achieve.[51,52] An example of a diagnosis in preterm babies and difficulty in interpretation of growth is the lung condition bronchopulmonary dysplasia (BPD). Rates of growth among infants with BPD are different from those of full-term infants and preterm infants who do not have BPD. While infants with BPD are recovering, their growth pattern is affected for the entire first year of life.[53] The reasons for the slower growth are increased nutritional requirements, changes in endocrine and pulmonary systems, and perhaps interaction among these systems.

enteral feeding Method of delivering nutrients directly to the digestive system, in contrast to methods that bypass the digestive system.

parenteral feeding Delivery of nutrients directly into the bloodstream.

9.4 Nutrition for Infants with Special Health-Care Needs

Infants who are small or sick near the time of birth may have major growth and feeding problems. Infancy is a vulnerable time of life, so health conditions occurring this early can impact growth and development. Over time, most of these problems resolve, although some may persist. Nutrition plays an important part in preventing illness, maintaining health, and treating certain conditions in infancy. Table 9.2 shows potential nutrition problems in infants with special health-care needs.

Nutrition Risks to Development

Infants and children with neurodevelopmental disorders or developmental delays more often have feeding difficulties, and oral-motor and swallowing problems.[54] They are also at increased risk for other nutrition-related problems including altered growth (failure to thrive, obesity, slow growth velocity), drug–nutrient interactions, and the need for **enteral** or **parenteral feedings**.[55] A developmental disability may be related to chromosomal abnormalities,

Table 9.2 Potential nutrition problems in infants with special health-care needs

Growth	Slow rate of weight gain Accelerated rate of weight gain Slow linear growth Disproportionate weight for length
Nutritional Adequacy	Increased or decreased energy needs Altered nutrient requirements Vitamins, minerals, or cofactors (such as carnitine) required in higher or lower amounts
Feeding	Disruption of the delivery of nutrients as a result of: • Altered structure or function of the mouth, oral cavity, or gastrointestinal tract • Disrupted interaction or response to cues between the infant and caregiver • Difficulty with achieving or maintaining adequate positioning when feeding • Lengthy duration or increased energy expenditure with feedings

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congenital anomalies, inherited metabolic disorders, or certain syndromes, or may not be associated with any diagnosed condition.[55] A high percentage—70 to 90 percent—of children with special health-care needs were found to have nutrition-related problems.[4] Nutrition diagnoses relating to feeding are varied, and examples include breastfeeding difficulty, swallowing difficulty, and altered gastrointestinal function.[56]

Not all infants with a developmental delay have developmental disabilities that continue into childhood. An infant with respiratory problems may experience slower growth and have higher energy needs related to increased work of breathing. This infant may initially be identified with developmental delay but soon after achieves age-appropriate developmental skills. This child would not meet the criteria of having a developmental disability. Other examples are infants from high-risk pregnancies, and those born large for gestational age related to poorly controlled gestational diabetes. Some of these infants require short stays in the neonatal intensive care unit for glucose regulation or poor feeding, while others may have developmental delays that persist. After infancy, when standardized testing and evaluation can be performed, the term developmental delay may be replaced with a more specific medical or developmental diagnosis.[52]

9.5 Severe Preterm Birth and Nutrition

Nutrition in early infancy has a key role in immediate neonatal survival, growth, neurodevelopment, and long-term health.[5,57] Despite advances in the care of extremely preterm infants, moderate to severe deficits in academic achievement, behavioral and attention problems, and poor executive function have frequently been reported.[58] Adequate energy and nutrients are provided by **parenteral nutrition support**, followed by a slow transition to enteral feeding. Preterm infants have high metabolic rates and will use fat stores and protein in tissues and muscles to meet glucose needs if provision of energy is not adequate.

How Sick Babies Are Fed

The guiding principles for feeding preterm infants are to provide nutrients to approximate the growth rate and composition of growth that would have occurred *in utero*; to maintain normal concentrations of blood and tissue nutrients; and to achieve appropriate functional development.[59] For preterm infants, breast milk is the desired feeding[60,61] and milk from their own mothers is the optimal enteral feeding choice.[13,19] Donor breast milk is primarily provided by mothers of term infants. It is pooled, pasteurized, tested for HIV and infections, and frozen when stored. There are established operational guidelines for human milk banks.[62]

Donor milk and term human milk are lower in protein than preterm human milk, which is the milk obtained after a premature delivery. All human milk will need to be fortified to meet the nutritional needs of extremely preterm and very preterm infants. Higher intakes of mother's own breast milk were protective; they were associated with lower incidence and severity of necrotizing enterocolitis (NEC), late-onset sepsis, and decreased length of stay.[63]

There are gastrointestinal conditions that could interfere with feeding preterm infants and sick neonates such as decreased gut motility, impaired absorption, and gastroesophageal reflux. These conditions, however, do not rule out enteral feeding, which stimulates the secretion of gastrointestinal hormones, gut motility, and maturation.

Feeding methods are selected based on the projected length of time the infant will need to achieve successful bottle or breastfeeding/chestfeeding. **Gavage feedings** are often needed by preterm infants because coordination of their suck-swallow-breathe pattern does not generally occur until 32 to 34 weeks gestational age. Gavage feedings are tube feedings originating from the mouth to the stomach (orogastric) or from the nose to the stomach (nasogastric). Other enteral routes include **gastrostomy** and **jejunostomy feeding**. These methods are used when enteral nutrition is expected to be needed long term, generally over three months.[64]

Food Safety

Preterm babies have immature immunological systems and are more susceptible to infection. Every effort should be made to ensure their feedings meet food safety requirements. Contamination of feeding equipment increases with time; consequently, hospitals have implemented policies requiring changing of tube feeding assemblies every 4 hours and limiting duration of hang time of continuous feeds to 4 hours.[65] Formula powder is not sterile; liquid concentrates and ready-to-feed formulas are sterile products and are recommended when nutritionally appropriate.[68] Freshly expressed, frozen, and donor breast milk are closely tracked and monitored in the neonatal intensive care unit (NICU) to assure that all infants are provided with the correct milk feeding.

parenteral nutrition support Intravenous nutrition or orally modified formulas needed because of inability to consume a regular diet.

gavage feeding A procedure where a tube is passed through the nose or mouth into the stomach. This is used to feed preterm or newborn infants who are not yet able or have weak or uncoordinated ability to suck and swallow.

gastrostomy feeding Form of nutrition support for delivering nutrition via a tube placed directly into the stomach. A surgical procedure creates an opening through the abdominal wall and stomach.

jejunostomy feeding Another form of nutrition support that delivers nutrition via tube directly into the small intestine.

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Courtesy of Robyn Wong

Photo 9.3 Former term infant with a history of cardiac surgery who was eating solid foods for the first time.

What to Feed Preterm Infants

Term infants achieve mature patterns of sucking and swallowing within days following birth. Preterm infants will begin to display a nutritive suck at approximately 34 weeks; it may be immature in pattern.[66] They will need to remain on tube feedings while oral feeds are initiated and advanced. Prior to 34 weeks, preterm infants can benefit when put to the breast to elicit **nonnutritive sucking**. Nonnutritive sucking is defined as the act of sucking or suckling with little or no secretion of milk.[67] This can be observed when infants suck on a pacifier, or at breast after a mother has expressed her milk. Nonnutritive sucking has been found to decrease the length of stay in hospitalized preterm infants and facilitate transition from tube to bottle feeding.[68]

Nutrition problems including impaired growth may be seen in infants with congenital heart disease. Photo 9.3 shows a former term infant with a history of cardiac surgery who was eating solid foods for the first time. The velocity of growth and weight gain improved following her surgery. The incidence of IUGR is approximately 6 percent among infants with symptomatic heart disease.[69] Case Study 9.2 (later in this chapter) discusses the nutritional concerns of an infant with a cardiac condition.

Breast milk is the recommended source of nutrition when initiating enteral feeds for preterm infants.[60,63] A meta-analysis of the nutrient content of preterm and term breast milk reported that postnatal age and gestational stage (preterm versus term) were important predictors of the protein content of breast milk. Colostrum and preterm breast milk were higher in protein than term milk. The energy content of preterm and term milk was comparable at all postnatal ages.[70]

Encouraging new birthing parents to pump frequently will help to stimulate breast milk production.[67] Barriers to breastfeeding/chestfeeding premature and sick newborns are related to their gestational age, developmental readiness, health status, and the practices in the NICU. Pasteurized donor milk is recommended if mother's milk is not available or contraindicated. Chapter 7 provides information regarding conditions when feeds of human milk are not recommended.

When breast milk is not available or contraindicated, preterm infant formula is an option. It contains higher energy and nutrient levels than standard infant formula (Table 9.3). The disadvantage of these formulas, however, is that their use is associated with higher rates of **necrotizing enterocolitis (NEC)** in preterm infants.[63] Necrotizing enterocolitis is a very serious condition that affects the intestinal tract of preterm infants. Bacterial infection and

Table 9.3 Selected nutrients in term, premature post-discharge, and premature infant formulas per 100 mL

Nutrient	Term 20 cal/oz	Post-Discharge 22 cal/oz	Premature 24 cal/oz
Energy, kcal	68	74	80
Protein, g	1.35	2.1	2.7
Vitamin A, IU	200	330	1,100
Vitamin D, IU	41	56	240
Vitamin E, IU	1.35	3.0	5.1
Thiamin, mcg	54	134	162
Riboflavin, mcg	95	149	240
Niacin, mcg	680	740	3,200
Vitamin B_6, mcg	41	50	122
Vitamin B_{12}, mcg	0.2	0.22	0.2
Vitamin C, mg	8.1	11.9	16.2
Folic acid, mcg	10.8	19.3	32.0
Calcium, mg	53	89	134
Phosphorus, mg	29	49	73
Magnesium, mg	5.4	6.0	7.3
Iron, mg	1.22	1.34	1.46
Zinc, mg	0.68	0.74	1.22

Source: Mead Johnson Nutrition, hcp.meadjohnson.com, accessed February 27, 2022.

nonnutritive sucking The sucking by newborns and young infants on items that do not provide fluid or nutrition.

necrotizing enterocolitis (NEC) Condition with inflammation or damage to a section of the intestine, with a grading from mild to severe.

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inflammation can cause bowel wall destruction, intestinal perforation and require surgical intervention. Overwhelming NEC can result in death.

The energy content of human milk is variable; generally it is approximately 20 kcal per oz. Standard infant formulas contain 20 kcal per oz. Preterm infants typically need high calorie feeds that provide 22–24 kcal per oz, or sometimes higher-calorie feeds such as 26, 28, or 30 kcal per oz. Higher calorie feeds may be needed to support the growth of extremely preterm infants and infants on fluid restriction or with conditions such as bronchopulmonary dysplasia. Close nutritional monitoring is needed to evaluate the effectiveness of the feeding plan.

Preterm Infants and Feeding The goal of feeding preterm infants is the same as for term infants—to achieve appropriate patterns of linear growth and weight gain and appropriate feeding skills for their *corrected age*. An infant born 3 months prematurely would at 9 months of age have a corrected age of 6 months. Nutrition and feeding recommendations for 6-month-old infants would be appropriate guidance for this infant and his family.

Most families enjoy feeding their infants and experience few long-term feeding problems. Infants who were born preterm, however, might be more difficult to feed.

Preterm infants and infants with chronic health problems may be more irritable and less able to signal their wants and needs compared to healthy infants. A meta-analysis report related an overall prevalence of problematic feeding in infants and children born prematurely was 42 percent.[71]

Some of the reasons for this include:

- *Lethargy*. Low levels of arousal in preterm infants may reduce duration of effective feeding.
- *Low tolerance of volume*. Abdominal distension may alter breathing and heart rate, so that the infant stops feeding.
- *Stress responses connected to feeding*. "Disorganized feeding" may result from the infant's prior unpleasant oral-tactile experiences while in the NICU—for example, suctioning, use of nasogastric and **orogastric (OG) feedings**, and delayed introduction of nonnutritive sucking or nipple feeding. Oral stimulation and feeding attempts may elicit stress responses rather than pleasure.

Former 29 weeks gestation, very low birth weight triplets are seen in Photo 9.4. Growth velocities were steadily progressing along the 10th to 25th percentile.

Certain feeding characteristics of preterm infants are distinct from those of term infants (Table 9.4). Feeding skills of most preterm infants improve over time. Anxiety decreases as parents become more comfortable and adept in caring for their infants at home. The underlying reflexes that associate pleasure with feeding reemerge, and the interactions between infants and caregivers will continue to improve (Case Study 9.1).



Robyn Wong

Photo 9.4 Former 29-week gestation VLBW triplets visiting the NICU.

Table 9.4 Signs of feeding problems in high-risk infants

In Early Infancy (Under 6 Months of Age)[1,55]
• The infant has an abnormal sucking pattern, which can be arrhythmic or disorganized. A weak suck or poor seal around the nipple may contribute to fluid loss; a poor seal allows breast milk or formula to run out of the mouth.
• Lengthy duration of feedings can tire the infant and the caregiver and increase the infant's energy expenditure.
• Gagging, coughing, choking during the feeding, or noisy breathing after the feeding may suggest problems with swallowing.
• Baby may appear to be hungry all the time because of low nippled volumes and is unable to nipple higher volumes over time.
In Later Infancy (Over 6 Months of Age)
• The baby is not able to maintain adequate head and trunk control while being fed from a spoon.
• The baby drinks from a bottle but does not readily accept baby foods after repeated attempts.
• The baby resists, gags, coughs, or chokes on foods with increased texture.

9.6 Infants with Congenital Anomalies and Chronic Illness

Some infants are born at term but require neonatal intensive care because of cardiac, genetic, or chromosomal conditions such as cardiac malformations, central nervous system defects such as spina bifida, and chromosomal anomalies. These are examples of **congenital anomalies**. In 1998, all grain products in the United States labeled as "enriched" are fortified with folic acid. This resulted in a 28 percent reduction in the prevalence of spina bifida and anencephaly, both neural tube defects.[72]

"Children with special health-care needs" is defined as children who have or are at increased risk for chronic

orogastric (OG) feeding A form of enteral nutrition support for delivering nutrition via tube placed from the mouth to the stomach.

congenital anomalies Conditions evident in newborns that are diagnosed at or near birth, usually as a genetic or chronic condition, such as spina bifida or cleft lip and palate.

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Case Study 9.1 Premature Birth at 27 Weeks Gestation

Erica is a former 27-week female, birthweight 1140 grams, and birth length 38.0 centimeters; her weight, length, and head circumference measurements were appropriate for her gestational age. She was born to a 32-year-old woman with hypercholesterolemia and a pre-pregnant BMI of 18. This was her second pregnancy; she and her husband also have a 20-month-old daughter.

Respiratory support and parenteral feeds of amino acids and dextrose were initiated on the day of delivery. The day after birth, small volumes of mother's own breast milk were introduced via orogastric tube but were discontinued because of suspected intolerance. Breast milk was reintroduced three 3 days later. Erica's mother had a very good milk supply.

There were multiple occurrences of abdominal distension and periods when enteral feeds were put on hold. Erica's tolerance to fortified breast milk feeds slowly improved, and fortified feeds of breast milk were initiated at 18 days of age. Erica received parenteral nutrition for a total of 20 days. She was diagnosed with anemia of prematurity and received two blood transfusions during her stay.

Throughout this time, Erica's weight and length progressed appropriately. Her head circumference showed minimal growth over a 3-week period. The concentration of her feeds was increased to 26 kcal per oz. Because of suspected gastroesophageal reflux, the volume of her feeds was decreased and feeding concentration increased to 28 kcal per oz. Mom continued to provide breast milk for all of Erica's feedings.

Breastfeeding was initiated when Erica was 33 weeks postmenstrual age. Respiratory support was discontinued at 36 weeks postmenstrual age. At 37 weeks postmenstrual age, she was bottle feeding and breastfeeding well and no longer needed tube feedings.

Erica had a 105-day stay in the NICU. She remained anemic, and iron and multivitamin supplements were continued at discharge. The recommended discharge feeding plan was comprised of ad lib breastfeeding, expressed breast milk and supplemental feeds of 22 kcal post-discharge formula daily. At time of discharge, Erica's weight, length, and head circumference were at the 50th percentile on the Fenton growth chart for preterm infant girls. Her mom's milk supply continued to be very adequate, and Erica was breastfeeding well. She was enrolled in the **Early Intervention Program** and was achieving appropriate developmental skills for her corrected age. At 6 months' corrected age, complementary foods were introduced and Erica transitioned off supplemental feeds of post-discharge formula to exclusive feeds of breast milk and breastfeeding.

Erica continued to meet nutrition and growth goals. At 15 months of age, she was a corrected age of 12 months and all growth measurements were above the 50th percentile on the WHO Growth Charts for Girls.

Questions

1. What effects did Erica's preterm birth have on her nutrition and feedings? On her growth?
2. What are the nutritional issues that need to be monitored after Erica's discharge?
3. What are the signs that Erica can outgrow these problems?



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physical, developmental, behavioral, or emotional condition and who also require health and related services of a type or amount beyond that required of children generally.[2] Approximately 20 percent of children in the United States under the age of 18 years have a special health-care need. They would be eligible for a wide range of medical, nutritional, and educational services to maximize their growth and development.[2] Nutrition assessments can identify problems such as inadequate linear growth or weight gain, inadequate energy or nutrient intake, or delayed progression in the infant's diet (Table 9.2). Major nutritional impacts are exemplified by disorders that involve the gastrointestinal tract.

Early Intervention Program Educational intervention for the development of children from birth up to 3 years of age.

cleft lip and palate Condition in which the upper lip and/or palate are not completely formed and in need of surgical correction. The cleft may contribute to feeding problems in early infancy.

Another example of a congenital anomaly identified in infancy is **cleft lip with or without cleft palate,** or **cleft palate.** A cleft of the palate is associated with increased risk for ineffective feeding because of difficulty in establishing an effective seal, suck, and swallow. A team approach is needed, as these infants are also at risk for hearing, speech, and dental problems. Use of special nipples and feeding devices can facilitate bottle feedings and improve feeding volumes.

Infants with Genetic Disorders

Infants diagnosed with genetic disorders near birth are a small subset of infants with congenital anomalies or

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chronic conditions. They may also fit into the classification of infants with special health-care needs. Prenatal genetic testing enables families to learn that their baby will have a specific medical or health condition prior to birth.

The number of genetic disorders that can be identified in newborns has been increasing, particularly through Expanded Newborn Screening Programs across the United States. Expanded newborn screening and follow-up have enabled more newborns to receive timely diagnosis and treatment. Some of these conditions require specific medical treatment and nutritional support, and use of therapeutic formulas known as medical foods. Infants with genetic conditions such as phenylketonuria and galactosemia will need dietary interventions and restriction of specific compounds. Failure to implement medical and nutritional treatment protocols can result in intellectual and developmental disabilities, metabolic crises, neurological crises, growth failure, and in some cases, death.[26]

Genetic centers and metabolic clinics are notified when a newborn screening result needs follow-up. Immediate action is taken to contact the family and assure confirmatory work-up. For example, an infant with galactosemia who is not picked up by the initial abnormal screening result, is at risk of hospitalization with possible sepsis, liver or kidney problems by the time a second screening sample is collected. If the baby with galactosemia receives timely medical treatment and dietary intervention, recovery is usually rapid. Some of the disorders picked up by newborn screening do not make the infant ill in early infancy, but signs, symptoms, or other concerns could present later, such as poor feeding and lethargy. It may sometimes be difficult for parents of a well-appearing newborn to learn that a special diet is needed to prevent serious illness or significant consequences in the future. An example of a condition that can be picked up by newborn screening before illness presents is cystic fibrosis.

Case Study 9.2 discusses a child with a cardiac condition.

Case Study 9.2 Noah's Cardiac Condition

Noah is a former late preterm male, born at 36 weeks gestation. He weighed 2000 g and was small for gestational age. His mother's medical history included chronic hypertension, obesity, and gestational diabetes. Noah was diagnosed prenatally with a cardiac condition that could affect his ability to feed.

His mother planned to breastfeed Noah and has been successful at expressing her milk and maintaining her breast milk supply. Noah has a weak suck and tires easily at the breast. He drinks small volumes, 1 to 1 ½ oz from a bottle. The feedings can last 30 minutes or longer.

At discharge, the family is referred to the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) program and to the state Children with Special Health-Care Needs program. Specialty cardiac clinic and local follow-up appointments are made. Feeding difficulties concern the family, and both a lactation consultant and a registered dietitian are involved prior to and after Noah's discharge.

Noah nurses frequently but briefly due to fatigue. Growth is slower than expected, but the cardiologist does not think Noah's slow weight gain is a result of his cardiac condition. Noah continues to nipple small volumes even after his family implements the recommendations from the lactation consultant. The registered dietitian recommends increasing the caloric density of breast milk with the addition of infant formula powder. The family feels that this recommendation may interfere with Noah's mother's desire to nurse him. She is unsure about implementing this change. Noah likes to nurse; feedings are brief and Noah is not able to empty the breast to obtain the higher fat/higher calorie hindmilk. Over time, his family starts to introduce baby foods from a spoon and his mom continues to breastfeed. Noah's weight is increasing slowly; his length and head circumference are progressing along the 10th percentile. Because of his slow weight gain, his weight-for-length percentile has fallen to the 3rd percentile.

Noah's family enjoys the interactions during feedings and feels that Noah is doing well for an infant with a cardiac problem. They have not contacted the WIC program or the Children with Special Health-Care Needs program. Some people they meet assume that Noah was a premature baby, but his small size is not of concern to his parents.

Questions

1. How do breastfeeding/chestfeeding and feeds of breasts milk benefit Noah?
2. How would you know if Noah's nutritional intake is sufficient?
3. Why might his family not desire services and benefits from the WIC program or Children with Special Health Needs Care program?
4. What next steps would you recommend to help Noah with his weight gain?



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9.7 Nutrition Interventions

When feeding problems are identified in infancy, interventions are needed to support optimal growth and development (Table 9.4). Interventions may include any of the following:

- Monitor weight, length, and head circumference more frequently.
- Monitor fluid and food intakes, assess adequacy of macro and micro nutrients. Acknowledge that intakes may be affected by illness, congestion, or medication use.
- Change the frequency, volume, or caloric density of breast milk, formula, or complementary foods as needed to meet nutrition goals.
- Modify the timing of breastfeeding/chestfeeding meals and snacks to fit medication or sleep schedules.
- Adjust nutrition and feeding goals based on the infant's developmental skills.

9.8 Nutrition Services

Infants who were born preterm or with special health-care needs may qualify for nutrition-related services and programs. Some of these include:

- Early Intervention Programs for infants and children from birth through 36 months of age who have developmental delays or disabilities. This program is funded through the Individuals with Disabilities Education Act (IDEA), Part C.
- Early Head Start for infants and toddlers under the age of 3 years. There is a nutrition focused program performance standard in Early Head Start.
- WIC Program
- State Children with Special Health-Care Needs programs

The following are some examples of how nutrition services may be accessed:

- Pediatric Specialty clinics, such as cardiology, neurology, pulmonology, gastroenterology, metabolic, and high-risk infant follow-up clinics frequently have registered dietitian-nutritionists on the specialty team.
- Specialty formulas, medical foods, and/or medical nutrition therapy may be provided through contractual agreements, health plan coverage, and enacted state laws.

Key Points

1. The number of infants at risk for having special health-care needs is increasing even though survival rates of preterm infants are improving over the decades.
2. Nutrition guidance for preterm infants and infants with special health-care needs are adjusted to their individual energy and nutrient needs.
3. Infants born extremely preterm will require higher intakes of protein and micronutrients per kilogram body weight than term infants.
4. Growth in infants with special health-care needs can be affected by factors such as intrauterine exposure to toxins, underlying medical condition, and chromosomal anomalies.
5. Feeding difficulties may be seen more frequently in infants who required intensive medical care and lengthy hospitalizations.
6. Some inborn errors of metabolism are identified in infancy and require medical treatment and nutrition support, including use of medical foods.

Review Questions

1. Why are infant feeding problems more common in extremely low birthweight and very low birthweight infants?
   a. The protein content in preterm human milk is lower than the protein content in term human milk.
   b. Preterm infants develop skills for feeding at breast/chest when they reach a postmenstrual age of 40 weeks.
   c. Impaired nutrient absorption and slow gut motility affect tolerance of feedings.
   d. Increased energy intakes are difficult to achieve because of the preterm infant's ineffective nippling skills.

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2. What factor contributes to increased nutritional requirements for an infant born at 28 weeks gestation?
   a. Preterm birth resulted in reduced body fat and nutrient reserves.
   b. Newborn reflexes persist and interfere with oral feeding.
   c. Feeding intolerance increases nutrient needs.
   d. The immaturity of the gastrointestinal tract increases energy needs.
3. Questions 3, 4, 5, and 6 concern an infant who was born at 32 weeks gestation and weighed 1200 grams (2 lb 10 oz). He is now 3 months old. *Answer true or false for each statement.* This infant has a chronological age of 3 months and a corrected age of 1 month.

   _____ True _____ False
4. Standard infant formula would be appropriate at this time.

   _____ True _____ False
5. This infant's nutritional needs can be met with exclusive feeds of breast milk.

   _____ True _____ False
6. Complementary foods can be introduced in 2 months.

   _____ True _____ False
7. Identify a genetic condition that can be identified with newborn metabolic screening.
8. Describe two or more factors other than nutrition that could impact growth of an infant with special health-care needs.
9. Describe two other modes of feeding infants in addition to breast and bottle feeding.

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Toddler and Preschooler Nutrition

Prepared by Judith E. Brown with Ellen Lechtenberg

Learning Objectives

After studying the materials in this chapter, you should be able to:

10.1 List two Healthy People 2030 objectives related to toddlers and preschool-age children.

10.2 Identify the screening tool used for assessing underweight, overweight, or children with obesity.

10.3 Describe two strategies that parents/caretakers can employ to encourage toddlers/preschoolers to accept a variety of foods in their diets.

10.4 Explain what influences energy needs of young children.

10.5 Identify one common nutritional problem of young children and describe prevention strategies.

10.6 Define children who are overweight or those with obesity.

10.7 Describe the components of a healthy diet for young children as recommended by health and professional organizations and agencies.

10.8 Identify the basic premise upon which Bright Futures Nutrition is based.

10.9 Identify one public food or nutrition program that provides services to young children and describe the program's strategies in improving the nutrition of young children.

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Introduction

This chapter describes the growth and development of toddlers and preschool-age children and their relationships to nutrition and the establishment of eating patterns. Growth during the toddler and preschool-age years is slower than in infancy but steady. This slowing of **growth velocity** is reflected in a decreased appetite; however, young children need adequate calories and nutrients to meet their nutritional needs. The eating and health habits established at this early stage of life may impact food habits and subsequent health later in life. The development of new skills and increasing independence marks the toddler and preschool stages. Learning about and accepting new foods, developing feeding skills, and establishing healthy food preferences and eating habits are important aspects of this stage of development.

Definitions of the Life-Cycle Stage

Toddlers are generally defined as children between the ages of 1 and 3 years. This stage of development is characterized by a rapid increase in **gross-** and **fine-motor skills** with subsequent increases in independence, exploration of the environment, and language skills. **Preschool-age children** are between 3 and 5 years of age. Characteristics of this stage of development include increasing autonomy; experiencing broader social circumstances, such as attending preschool or staying with friends and relatives; increasing language skills; and expanding ability to control behavior.

Importance of Nutrition

Adequate intake of energy and nutrients is necessary for toddlers and preschool-age children to achieve their full growth and developmental potential. Undernutrition during these years impairs children's cognitive development as well as their ability to explore their environments.[1,2] Long-term effects of undernutrition, such as failure to thrive and cognitive impairment, may be prevented or reduced with adequate nutrition and environmental support.

10.1 Tracking Toddler and Preschooler Health

The percentage of children living below the federal poverty level is a widely used indicator of child well-being.[1] The percentage of children living below the federal income supplemental poverty measure (SPM) threshold decreased by 46 percent from 9.7 percent in 2020 to 5.2 percent in 2021. The official child poverty rate decreased 0.7 percent during this same time from 16 percent to 15.3 percent, and has decreased from a high of 49 percent in 2012. Approximately 44 percent of related children under age 6 in families with a female householder were below the federal poverty level. This was more than four times the rate of their counterparts in married-couple families (9.5 percent). Individuals that are American Indian or Alaska Native comprise the largest share of young children living in low-income families (22.1 percent) and of children in this age group. Children of African American or Black, Native American and Alaska Native, and Latinx backgrounds are disproportionately low income compared to children of non-Latinx, European American, or White backgrounds.[3–6]

When evaluating young children's nutritional status and offering nutrition education to parents or guardians, it is important to consider children's home environments. Establishing healthy eating habits may be difficult to accomplish in home environments with incomes below the federal poverty level and experiencing food insecurity. Disparities in child health indicators, including those of nutrition status in this age group, exist among races and ethnicities.

Healthy People 2030

Healthy People 2030 includes a number of objectives that directly relate to toddlers and preschoolers in the topic areas of Food Safety, Nutrition and Weight Status (NWS), and Physical Activity (PA).[7] The NWS topic area includes objectives related to Healthier Food Access, Health-care Settings, Weight Status, Food Insecurity, Food and Nutrient Consumption (Table 10.1), and Iron Deficiency. Examples of objectives related to toddlers and preschoolers will be presented in the discussion of specific topics throughout this chapter.

10.2 Normal Growth and Development

An infant's birth weight triples in the first 12 months of life, but growth velocity slows thereafter until the adolescent growth spurt. On average, toddlers gain 8 oz (0.23 kg) per month and 0.4 in. (1 cm) of height per month, while preschoolers gain 4.4 lb (2 kg) and 2.75 in. (7 cm) per year.[8] This decrease in rate of growth is accompanied by a reduced appetite and food intake in toddlers and preschoolers. A common complaint of parents or guardians of children this age is that their children have a much lower appetite and a lower interest in food or eating compared to their appetite and food intake during infancy. Parents and

growth velocity The rate of growth over time.

toddlers Children between the ages of 1 and 3 years.

preschool-age children Children between the ages of 3 and 5 years who are not yet attending kindergarten.

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Table 10.1 Healthy People 2030 objectives in the Nutrition and Weight Status (NWS) topic area related to Food and Nutrient Consumption of the population aged 2 years and older[7]

Healthy People 2030 Objective		Baseline	Target
NWS-06	Increase the contribution of fruits to the diets of the population aged 2 years and older	0.51 cup equivalents of fruits per 1,000 calories	0.56 cup equivalents of fruits per 1,000 calories
NWS-07	Increase the contribution of total vegetables to the diets of the population aged 2 years and older	0.76 cup equivalents of total vegetables per 1,000 calories	0.84 cup equivalents per 1,000 calories
NWS-08	Increase the contribution of dark-green vegetables, orange vegetables, and legumes to the diets of the population aged 2 years and older	0.31 cup equivalents of dark green or orange vegetables or legumes per 1,000 calories	0.33 cup equivalents per 1,000 calories
NWS-09	Increase the contribution of whole grains to the diets of the population aged 2 years and older.	0.46 oz equivalents of whole grains per 1,000 calories	0.62 oz equivalents per 1,000 calories
NWS-15	Increase vitamin D consumption by people aged 2 years and over.	15.8 micrograms	19 micrograms
NWS-10	Reduce consumption of calories from added sugars in the population aged 2 years and older.	13.5% of total daily calorie intake	11.5%
NWS-14	Increase potassium consumption by people aged 2 years and over.	2,512 mg	2,763 mg
NWS-11	Reduce consumption of saturated fat in the population aged 2 years and older.	11.4% of total daily calorie intake	8.4%
NWS-12	Reduce consumption of sodium in the population aged 2 years and older.	3,406 mg	2,725 mg
NWS-13	Increase consumption of calcium in the population aged 2 years and older.	1,077 mg	1,184 mg

Source: U.S. Department of Health and Human Services. 2030 Topics & Objectives: Nutrition Weight Status. https://health.gov/healthypeople/objectives-and-data/browse-objectives/nutrition-and-healthy-eating/increase-vitamin-d-consumption-people-aged-2-years-and-over-nws-15.

guardians need to be reassured that a decrease in appetite is part of normal growth and development for children in this age group.

Measuring Growth

In monitoring a child's physical growth, it is important for children to be accurately weighed and measured at periodic intervals. Toddlers less than 2 years of age should be weighed without clothing or a diaper. The **recumbent length** of toddlers should be measured on a length board with a fixed head board and movable foot board. Proper measurement of recumbent length requires two skilled practitioners but may involve a practitioner and caretaker—one at the child's head making sure the crown of the head is placed firmly against the headboard, and the other making sure that the child's legs are fully extended and placing the foot board at the child's heels (Photo 10.1). Preschool-age children should be weighed and measured without shoes and in lightweight clothing. Calibrated scales should be used and a height board should be used for measuring **stature** (Photos 10.2 and 10.3). It is important that both weight and height be plotted on the appropriate growth charts, such as the World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) growth charts discussed next.

recumbent length Measurement of length while the child is lying down. Recumbent length is used to measure toddlers less than 24 months of age and those between 24 and 36 months who are unable to stand unassisted.

stature Standing height.



BSIP/Science Source

Photo 10.1 Measuring the recumbent length of a toddler is a two-person job!

The WHO and CDC Growth Charts

The CDC and the American Academy of Pediatrics (AAP) recommend the following charts be used to monitor growth in infants and children: The WHO growth charts

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Hispanolistic/E+/Getty Images

Photo 10.2 Young child being weighed.



Lik Studio/Shutterstock.com

Photo 10.3 Measuring the stature of a preschool-age child.

be used for children aged birth to younger than 2 years, regardless of type of feeding and the CDC growth charts for children aged 2 until aged 20 years. The WHO charts were developed as growth standards, which demonstrate how healthy children grow under optimal conditions.[6]

The CDC growth charts are based on data from cycles 2 and 3 of the National Health and Examination Survey (NHES) and the National Health and Nutrition Examination Survey (NHANES) I, II, and III, and they provide a reference for how children in the United States are growing.[9] Charts are gender specific. With these charts, the health-care professional can plot and monitor weight-for-age, length- or stature-for-age, head-circumference-for-age, weight-for-length, weight-for-stature, and BMI-for-age. Children's growth usually "tracks" within a fairly steady percentile range. It is important to monitor a child's growth over time and to identify any deviations in growth. It is the pattern of growth that is important to assess rather than any one single measurement. A weight measurement without a length or stature measurement will not indicate how appropriate the weight is for the child's length or stature. There are Internet-based programs and apps for smartphones and tablets available that will compute exact growth percentiles, but tracking and assessing growth curves over time are still essential.

Body mass index (BMI) is predictive of body fat for children over 2 years of age, as BMI normative values are not available for children less than 2 years of age.[10] For children 2 years of age or older, a BMI in the 85th percentile or greater but less than the 95th percentile indicates overweight, and a BMI in the 95th percentile or greater indicates obesity.[10] For children less than 2 years of age, a weight-for-length greater than the 95th percentile is considered overweight.[10] A weight-for-length or a BMI for age percentile less than the 5th percentile indicates underweight in all age categories. BMI fluctuates throughout childhood. BMI increases in infancy; it decreases during preschool years, hitting its lowest point at approximately 4–6 years of age; and then it increases into adulthood. Because of this normal fluctuation of BMI, the only way to know whether a child's BMI is within a normal range is to plot BMI-for-age on the appropriate growth curve. The CDC added a new extended BMI for age growth chart in December 2022 for boys 2–20 years and girls 2–20 years with a BMI up to 60 to be used for individuals with a BMI above 97 percent.[9] In pediatrics, the goal is to strive for a BMI-for-age percentile in the normal range and not a specific BMI value, as is the goal in adults. Healthy People 2030 objective NWS-04 is to reduce the proportion of children and adolescents with obesity.[7] Growth charts visually aid parents by demonstrating the expected slowing of the growth velocity during the toddler and preschool stage of development. Although the curves for weight-for-age and length- or stature-for-age continue to increase during the toddler and preschool-age years, the slope of the curve is not as steep as it is during the first year of life.

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WHO Growth Standards

In 2006, the WHO published growth standards for children from birth to 5 years of age, based on growth data collected over time on healthy breastfed infants and young children in six different countries. The mothers of these children were nonsmokers and the children had adequate diets and were free of infections. WHO growth standards are available for boys and girls from birth to five years of age for length/height-for-age, weight-for-age, weight-for-length, weight-for-height, and BMI-for-age (www.who.int/childgrowth or the CDC website at www.cdc.gov/growthcharts/who_charts.htm).[11] Figure 10.1 shows an example of one of the charts, which depicts the growth of a healthy child.[8,9]

Common Problems with Measuring and Plotting Growth Data

Incorrectly measured or plotted growth parameters in young children can lead to errors in health status assessment. Standard procedures should be followed, calibrated, and appropriate equipment should be used, and plotting should be double-checked—including checking the age of the child—to avoid such errors. Choosing the appropriate growth chart based on how the child was measured (recumbent length versus stature) and on the child's gender is as important as using the current growth charts.

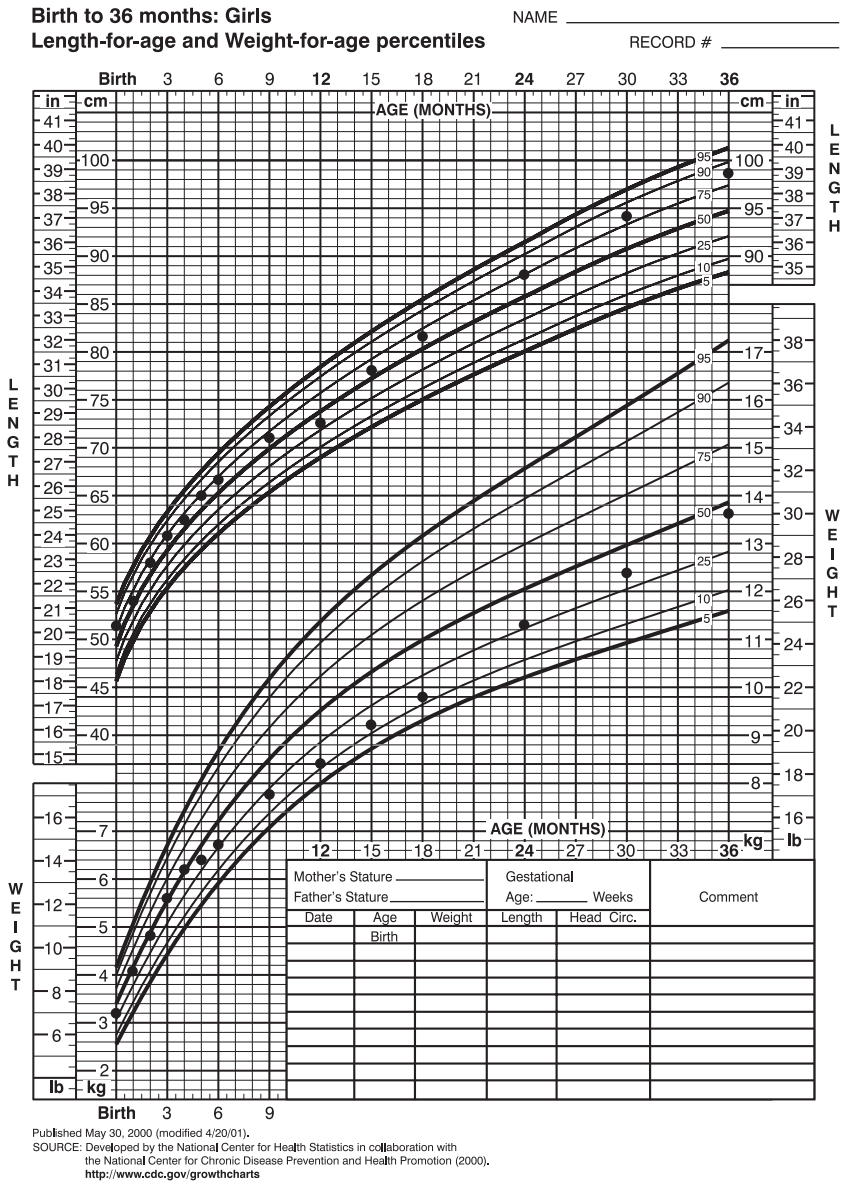


Figure 10.1 Birth to 36 months: Girls Length-for-age and Weight-for-age percentiles.[8]

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10.3 Physiological and Cognitive Development

Toddlers

Development of Feeding Skills in Toddlers Many babies begin to wean from the breast or the bottle at about 9–10 months of age, when their solid food intake increases, and they learn to drink from a cup.[12] Parents need to pay attention to cues of readiness for weaning, such as disinterest in breastfeeding or bottle feeding. The time it takes to wean is variable and depends on both the child and the mother. Weaning will be easier for those babies who adapt well to change. Weaning is a sign of the toddler's growing independence and is usually complete by 12–14 months of age, although the age varies from child to child. The AAP recommends that breastfeeding continue for at least 12 months, and thereafter for as long as mother and baby desire. The WHO recommends continued breastfeeding up to 2 years of age or beyond.[12]

Gross- and fine-motor development during the toddler years enhances children's ability to chew foods of different textures and to self-feed. Between 12 and 18 months, toddlers are able to move their tongue from side to side (or laterally) and learn to chew food with rotary, rather than just up and down, movements. Toddlers can now handle chopped or soft table food.

At about 12 months, children have a refined pincer grasp that enables them to pick up small objects, such as cooked peas and carrots, and put them into their mouths. Children will be able to use a spoon around this age, but not very well. At 18–24 months, toddlers are able to use the tongue to clean the lips and have well-developed rotary chewing movements. Now the toddler can handle meats, raw fruits and vegetables, and multiple food textures.

A strong need for independence in self-feeding emerges during the toddler age. "I do it!" and "No, no, no!" are commonly heard phrases in households where toddlers reside. As toddlers practice their newfound skills, they become easily distracted. Parents need to realize that their toddler's sometimes-fierce independence is part of normal growth and development and represents an ongoing process of separation from dependency on the parents and caretakers.

By increasing fine-motor and visual-motor coordination skills, this allows toddlers to use cups and spoons more effectively. Although skill with a spoon increases during the second year, toddlers prefer to eat with their hands. Initial attempts at self-feeding are inevitably messy (Photo 10.4), but represent an important stage of development. It is important that parents and caretakers keep distractions, such as television, to a minimum during mealtimes, and allow their toddlers to practice self-feeding skills and to experience new foods and textures. The child derives pleasure in self-feeding and exploring new tastes. Learning to self-feed allows the child to develop mastery of an important part of everyday life.



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Photo 10.4 Toddler enjoying mealtime!

Adult supervision of eating is imperative due to the high risk of choking on foods at this age. Toddlers should always be seated during meals and snacks, preferably in a high chair or booster seat with the family, and not allowed to "eat on the run." Foods that may cause choking, such as hard candy, popcorn, nuts, whole grapes, and hot dogs, should not be served to children less than 2 years of age.[12]

Feeding Behaviors of Toddlers The toddler's need for rituals, a hallmark of this stage of development, may be linked to the development of food jags. Many toddlers demonstrate strong food preferences and dislikes. They can go through prolonged periods of refusing a particular food or foods they previously liked. The intensity of the refusal or the negative attitude toward a particular food will be influenced by the child's temperament (refer to the "Temperament Differences" section). To circumvent food jags, parents can serve new foods along with familiar foods. New foods are better accepted if they are served when the child is hungry and if she sees other members of the family eating these foods. Eventually, toddlers' natural curiosity will get the best of them. Toddlers are great imitators, which includes imitating the eating behavior of others.

Mealtime is an opportunity for toddlers to practice newly acquired language and social skills and to develop a positive self-image. It is important for caregivers to offer a variety of foods and textures but not to force a toddler to eat. Battles over food intake should be avoided, as family mealtime should provide an opportunity for parents and caretakers to model healthy eating behaviors for the young child; establishing the habit of eating breakfast is also an important part of healthy eating behaviors.

Appetite and Food Intake of Toddlers Parents and guardians need to be reminded that toddlers naturally have

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a decreased interest in food because of slowing growth, and a corresponding decrease in appetite. Besides, with all of their newfound gross- and fine-motor skills, they have places to go and new environments to explore! It is a part of normal growth and development for toddlers to be easily distracted at mealtime.

Toddlers need toddler-sized portions. One rule of thumb for serving size is 1 Tbsp of food per year of age. Applying this rule, a serving for a 2-year-old child would be about 2 Tbsp. It is better to give the child a small portion and allow him to ask for more than to serve large portions. Parents and guardians often overestimate portion sizes needed by their young child, which may contribute to labeling the child as a "picky" eater. Because toddlers can't eat a large amount of food at one time, snacks are vital in meeting the child's nutritional needs. It is important, however, that toddlers not be allowed to "graze" throughout the day on sweetened beverages and foods such as cookies and chips. These foods can blunt their limited appetite for basic foods at meal and snack times.

In considering the toddler's need for rituals and limit setting, parents and caretakers need to establish regular but flexible meal and snack times, allowing enough time between meals and snacks for the toddler to get hungry. It is important that toddlers be allowed to control the amount of food eaten by hunger rather than by parental pressure to eat more (Case Study 10.1).

Preschool-Age Children

Preschool-age children continue to expand their gross- and fine-motor capabilities. At age 4, the child can hop, jump on one foot, and climb well. The child can ride a tricycle, or a bicycle with training wheels, and can throw a ball overhand.[8]

Development of Feeding Skills in Preschool-Age Children The preschool-age child can use a fork and a spoon and uses a cup well. Cutting and spreading with a knife may need some refinement. Children should be seated comfortably at the table for all meals and snacks. Eating is not as messy a process during the preschool years as it was during toddlerhood. Spills still do occur, but they are not intentional. Foods that cause choking in young children should be modified to make them safer, such as cutting grapes in half lengthwise and cutting hot dogs in quarters lengthwise and then cutting into small bites. Adult supervision during mealtime is still imperative.

Feeding Behaviors of Preschool-Age Children As during the toddler years, parents of preschool-age children need to be reminded that the child's rate of growth continues to be relatively slow, with a relatively small appetite and food intake. Growth occurs in "spurts" during childhood. Appetite and food intake increase in advance of a growth spurt, causing children to add some weight that

Case Study 10.1 Mealtime with a Toddler

Josiah, a 22-month-old boy, lives with his mother and grandmother. He is at an early childhood center during the weekdays and, due to his mother's work schedule, does not get home until after 6 p.m. most days. His mother and grandmother allow him to walk around the house with apple juice in a sippy cup while they are preparing dinner. He also "demands" snacks such as crackers, slices of cheese, and cookies. When they attempt to put Josiah in his booster chair at the table, he fights with them and yells, "NO chair!" Mother and grandmother often eat quickly in front of the television while feeding Josiah from their plates while he also watches TV. Josiah's mother and grandmother expressed frustration and are concerned that he is not eating enough for dinner. The early childhood staff also state that they are having a difficult time with him sitting down at lunch time.

Questions

1. Describe the issues surrounding Josiah's mealtime behaviors.
2. Describe how Josiah's mother and grandmother could introduce new foods into Josiah's diet.
3. What suggestions can you give for between-meal snacks for Josiah?
4. What concerns do you have about giving Josiah unlimited access to apple juice in the sippy cup?
5. How can healthy eating behaviors be developed in Josiah?
6. Should Josiah be encouraged to eat all the food on his plate before he is allowed to get down from his booster chair and play? Why or why not?



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will be used for the upcoming spurt in height. Therefore, the appetite of a preschool-age child can be quite variable.

Preschool-age children want to be helpful and to please their parents and caregivers. This characteristic makes the preschool years a good time to teach children about foods, food selection, and preparation by involving them in simple food-related activities. For instance, outings to a farmers' market can introduce children to a variety of fresh vegetables and fruit. Allowing children to be involved in meal-related activities (Table 10.2) can be quite instructive.[13] Families of preschool-age children need to continue to be encouraged to eat together (Photo 10.5).

Innate Ability to Control Energy Intake An important principle of nutrition for young children, and one with direct application to child feeding, is children's ability to self-regulate food intake. If allowed to decide when to eat and when to stop eating without outside interference, children eat as much as they need.[14,15] Children have an innate ability to adjust their caloric intake to meet energy needs. The preschool-age child's intake may fluctuate widely from meal to meal and day to day. But over a week's time, the young child's intake remains relatively stable.[16,17] Parents who try to interfere with the child's ability to self-regulate intake by forcing the child to "clean her plate" or using food as a reward are asking the child to overeat or undereat.

Although children can self-regulate caloric intake, no inborn mechanisms direct them to select and consume a well-balanced diet.[18] Parents give up some control over what their preschool child eats if the child spends more time away from home in a child care center or with extended family members. Preschool-age children continue to learn about food and food habits by observing their parents, caretakers, peers, and siblings, and they begin to be influenced by what they see on television and through other forms of media.[17,19] Their own food habits and food preferences are established at this time.

Table 10.2 MyPlate meal preparation activities for young children[13]

At 2 years:
• Tear lettuce or greens. • Rinse vegetables or fruits. • Snap green beans.
At 3 years:
• Mash potatoes. • Squeeze citrus fruits. • Stir pancake batter.
At 4 years:
• Peel eggs and some fruits, such as oranges and bananas. • Crack eggs. • Help make sandwiches and tossed salads.
At 5 years:
• Measure liquids. • Cut soft fruits with a dull knife. • Use an eggbeater.

Source: U.S. Department of Agriculture. Picky eating: Kitchen activities. www.myplate.gov.



SeventyFour/Shutterstock.com

Photo 10.5 Sharing family meals is an important aspect of development in young children.

Appetite and Food Intake of Preschoolers Parents of a preschool-age child often describe their child's appetite as "picky." Approximately 14 to 50 percent of parents with preschool-age children identify them as picky eaters.[17] One reason a child may want the same foods all of the time is because familiar foods may be comforting to her. Another reason is that the child may be trying to exert control over this aspect of her life. The child's eating and food selection can easily become a battleground between parent and child and this scenario should be avoided. Some practical suggestions include serving child-sized portions and serving the food in an attractive way. Young children often do not like their foods to touch or to be mixed together, such as in casseroles or salads. They typically do not like strongly flavored vegetables and other foods, or spicy foods, at this young age. Just as with toddlers, parents of preschool-age children should not allow their children to eat and drink indiscriminately between meals and snacks. This behavior often causes a blunted appetite at mealtime. Children should not be forced to stay at the table until they have eaten a certain amount of food, as determined by the parent.

Temperament Differences

> "Better is a dinner of herbs where love is, than a fatted ox and hatred with it."
>
> —Proverbs 15:17

Temperament is defined as the behavioral style of the child, or the "how" of behavior. Three temperamental clusters have been defined: the "easy" child (about 40 percent of children), the "difficult" child (10 percent), and the "slow-to-warm-up" child (15 percent).[20] The remaining children,

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classified as "intermediate-low" or "intermediate-high," demonstrate a mixture of behaviors but gravitate toward one end of the spectrum.[20]

Children's temperaments affect feeding and mealtime behavior. The "easy" child is regular in function, adapts easily to regular schedules, and tries and accepts new foods readily. The "difficult" child, on the other hand, is characterized by irregularity in function and slow adaptability. This child is more reluctant to accept new foods and can be negative about them. The "slow-to-warm-up" child exhibits slow adaptability and negative responses to many new foods with mild intensity. With repeated exposure to new foods, this child can learn to accept them over time with limited complaining.[20]

The "goodness of fit" between the temperaments of the child and the parent or caretaker can influence feeding and eating experiences.[17,20] A mismatch can result in conflict over eating and food. Parents and caretakers need to be aware of the child's temperament when attempting to meet nutritional needs. The difficult or slow-to-warm-up child may pose special challenges that need to be addressed by gradually exposing the child to new foods and not hurrying him or her to accept them.[20]

Food Preference Development, Appetite, and Satiety

Food preference development and regulation of food intake have been studied extensively by Leann Birch and associates.[21,22] It is clear that children's food preferences do determine what foods they consume. Children naturally prefer sweet and slightly salty tastes and generally reject sour and bitter tastes. These preferences appear to be unlearned and present in the newborn period. Children eat foods that are familiar to them, a fact that emphasizes the importance environment plays in the development of food preferences. Children tend to reject new foods initially but may learn to accept a new food with repeated exposure to it. It may take 8–10 exposures to a new food before it is accepted. Children who are raised in an environment where all members of the family eat a variety of foods are more likely to eat a variety of foods. One study showed that 5-year-old girls' fruit and vegetable intakes were related to their parents' fruit and vegetable intakes.[23]

Children also appear to have preferences for foods that are energy dense due to high levels of sugar and fat.[21,22,24] These preferences may develop because children associate eating energy-dense foods with pleasant feelings of satiety, or because these types of foods may be associated with special social occasions such as birthday parties. The context in which foods are offered to a child influences the child's food preferences. Foods served on a limited basis but used as a reward become highly desirable. Restricting a young child's access to a palatable food may actually promote the desirability and intake of that food.[25] Coercing or forcing children to eat foods can have a long-term negative impact on their preference for these foods.[17,21-24]

preloads Beverages or food such as yogurt in which the energy/macronutrient content has been varied by the use of various carbohydrate and fat sources. The preload is given before a meal or snack and subsequent intake is monitored. This study design has been employed by Birch and Fisher in their studies of appetite, satiety, and food preferences in young children.[22]

Media Influence Young children are also influenced by media. One study of advertisements during programming aimed specifically at toddlers and preschool-age children on three different networks found that more than half of all food advertisements were aimed specifically at children, and the majority of these advertisements were for fast-food chains or sweetened cereals. The ads associated the advertised product with fun and/or excitement and energy. Fast-food ads seemed to focus on building brand recognition through the use of licensed characters, logos, and slogans and were less likely to show food during the ads.[26] Even after major food companies participating in the Children's Food and Beverage Advertising Initiative (CFBAI) industry voluntary self-regulation program, implemented in 2006, which pledged not to directly advertise for any of their products to children under 13, young children still see ads from these companies because most also watch commercial children's TV programs that are popular with older children. CFBAI has made several updates since 2006 regarding its Core Principles and nutrition criteria. The latest change, effective January 1, 2023, increased the age from under 12 years of age to under 13 years of age for direct advertising to children. In 2020, updates were made to criteria, changing total sugars to added sugars to be consistent with the Nutrition Facts labels.[27] The overall impact of the initiative is limited due to the low number of products listed along with a loophole that allows advertising within a brand family some products and not other products. A September 2021 report estimated that only 1 percent of total calories purchased by households with young children were from foods on the CFBAI product lists.[28]

Appetite, Satiety Children's energy intake regulation has been studied by giving children **preloads** of food or beverage of varying energy content followed by self-selected meals. In one such study, children ages 3–5 years were given either a low-energy preload beverage made with aspartame or a high-energy preload beverage made with sucrose. Fat and protein content of the preloads did not differ. Children were then allowed to self-select their lunches. Children who had a low-calorie beverage before lunch consumed more calories at lunch, while those who had a higher-calorie beverage consumed fewer calories. These results indicate that young children are able to adjust caloric intake based on caloric need.[22,29] Similar studies were conducted in

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2- to 5-year-olds using foods with dietary fat or Olestra, a nonenergy fat substitute. Results indicate that children compensated for the lower level of calories in food when Olestra was substituted for dietary fat.

The preloading protocol just described was also used to study children's responsiveness to caloric content of foods in the presence or absence of common feeding advice from adults. In one group, teachers were trained to minimize their control over how much the children ate. In the other group, teachers were trained to focus the children on external factors to control their intake, such as rewarding the children for finishing the portions served to them or encouraging them to eat because it was "time to eat." Results of this investigation show that when the adults focused the children on external cues for eating, children lost their ability to regulate food intake based on calories. It appears that children's innate ability to regulate caloric intake can be altered by child-feeding practices that focus on external cues rather than the child's own hunger and satiety signals.[29]

The effects of portion size on children's intakes were compared between classes of 3-year-old and 5-year-old children. The children were served a small, medium, or large portion of macaroni and cheese along with standard amounts of other foods in their usual lunchtime setting. Analysis of amount of food eaten showed that portion size did not affect the younger children's intakes; their intakes remained constant despite the amount of food served to them. In contrast, the 5-year-old children's intakes increased significantly with the larger portion sizes. The researchers conclude that by 5 years of age, children are influenced by the size of portions served to them, another external factor that influences intake.[30] A similar study in preschoolers with an average age of 4 years found that doubling an age-appropriate portion size of an entrée increased entrée and total energy intake by 25 percent and 15 percent, respectively.[31] These investigators raise the question of what effect large portion sizes have on overeating and, consequently, on the development of childhood overweight, and their results point to the possible benefits of allowing children to self-select their portion sizes.

Another study of 5-year-old girls and their parents looked at the effects of parents' restriction of palatable foods on their children's consumption of these foods. After a self-selected standard lunch, these 5-year-old girls were given free access to snack foods, such as ice cream, potato chips, fruit-chew candy, and chocolate bars. The daughters of parents who reported restricting access to snack foods indicated to the investigators that they ate "too much" of the snack foods and also reported negative emotions about eating the snack foods. Parents' restriction of foods actually promoted the consumption of these foods by their young daughters and, of even more concern, the daughters reported feeling badly about eating these "forbidden" foods.[32]

A related study found a lower self-concept in 5-year-old girls with high body weight.[33] Daughters of parents who restricted access to food and expressed concern about their daughter's weight status tend to have negative self-evaluations.[32] Ek et al. published a study on parental feeding practices using a questionnaire completed by 478 parents with 52 percent girls and 48 percent boys with a mean age of 5.5 years old in Sweden. The study confirmed previous research and showed a strong association of food avoidance following parental pressure to eat. The study also documented parental restriction was most common in parents with perceptions of their preschooler having big appetites with concern for weight status in their child.[34] Mothers in particular seem to have more influence over their young daughters' beliefs about food and dieting.[35] Satter describes the optimal "feeding relationship" as one in which parents and caretakers are responsible for what children are offered to eat and the environment in which the food is served, while children are responsible for how much they eat or even whether they eat at a particular meal or snack.[36] According to Satter, if this feeding relationship is respected, then feeding and potential weight problems can be prevented.[36]

What implications does all this research have on child feeding practices? Based on the results of these studies, it appears that by late preschool age, children are more responsive to external cues than to their innate ability to self-regulate intake (Table 10.3).[22] The importance of appropriate parenting skills in helping children learn to

Table 10.3 Practical applications of child-feeding research[22,24]

• Parents should respond appropriately to children's hunger and satiety signals.
• Parents should focus on the long-term goal of developing healthy self-controls of eating in children and should look beyond their concerns regarding composition and quantity of foods children consume or fears that children may eat too much and become overweight.
• Parents should not attempt to control children's food intakes by attaching contingencies ("No dessert until you finish your rutabagas") and coercive practices ("Clean your plate. Children in Bangladesh are starving").
• Parents should be cautioned not to severely restrict "junk foods," foods high in fat and sugar, as that may make these foods even more desirable to the child.
• Parental influence should be positively focused on the child developing food preferences and selection patterns of a variety of foods consistent with a healthy diet. Parental modeling of eating a varied diet at family mealtime will have a strong influence on children.
• Children have an unlearned preference for sweet and slightly salty tastes; they tend to dislike bitter, sour, and spicy foods.
• Children tend to be wary of new foods and tastes, and it may take repeated exposures to new foods before these are accepted.
• Children need to be served appropriate child-sized servings of food.
• Child feeding experiences should take place in secure, happy, and positive environments with adult supervision.
• Children should never be forced to eat anything.

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Table 10.4 Estimated energy requirements (in kcals) for reference boys and girls at selected ages and varying physical activity levels (PALs)[39,40]

Age/Gender	Reference Weight (kg [lbs])	Reference Height (m [in.])	Inactive PAL (kcal/day)	Low Active PAL (kcal/day)	Active PAL (kcal/day)	Very Active PAL (kcal/day)
3-year-old boy	14.3 (31.5)	0.95 (37.4)	1,008	1,159	1,139*	1,252
4-year-old boy	16.2 (35.7)	1.02 (40.2)	1,122	1,257	1,264	1,303
5-year-old boy	18.4 (40.5)	1.09 (42.9)	1,231	1,365	1,402	1,466
3-year-old girl	13.9 (30.6)	0.94 (37.0)	1,033	1,055	1,116	1,149
4-year-old girl	15.8 (34.8)	1.01 (39.8)	1,103	1,151	1,212	1,282
5-year-old girl	17.9 (39.4)	1.08 (42.5)	1,175	1,249	1,310	1,417

*Calculations based on 2023 estimated energy reqirement (EER) equations. Estimates for the active 3-year-old boy kcal/day may be higher based on other calculations in chart (1,159–1,200 kcal/day).

Source: Data from National Academy of Sciences, Institute of Medicine, Food and Nutritional Board.

self-regulate food intake and possibly avoid problems with obesity is echoed by a panel of obesity experts.[10,37,38] Birch's research also reinforces the important role that parents and caretakers play in modeling healthy eating behaviors for young children.

10.4 Energy and Nutrient Needs

Dietary Reference Intakes (DRIs) were developed from 1997 through 2010 and are continuingly updated based on science. The series of reports presents a comprehensive set of reference values for nutrient intakes for healthy individuals and populations in the United States and Canada. In the pediatric age range, reference intake values are available for females and males aged 0.0–0.5 year, 0.5–1 year, 1–3 years, 4–8 years, and 9–13 years of age. Information about the various DRI publications can be found on the National Academy Press website (www.nap.edu). Published DRI tables are provided at the end of this book.

Energy Needs

DRIs have been established for the energy needs of young children.[39,40] The energy DRIs have been updated in 2023 with requirements based on age/sex, physical activity, and life-stage group. Age groups for toddlers are part of the 6 months to 2.99 years. Preschoolers are in the 3 to 13.99 years group. The formula for Estimated Energy Requirements (EER) for boys ages 6 to 35.99 months is $-716.45 - (1.00 \times \text{age}) + (17.82 \times \text{height in cm}) + (15.06 \times \text{weight in kg}) + 20$ kcal. A healthy 24-month-old girl who weighs 12 kg and is 88 cm. tall would use the EER equation $(-69.15 + (80.0 \times \text{age}) + (2.65 \times \text{height}) + (54.15 \times \text{weight}) + 15$ kcal for an EER of 989 kcal/day. Beginning at age 3, the DRI equations for estimating energy requirements are based on a child's gender, age, height, weight, and physical activity level (PAL). Physical activity level must be included for all people age 3 and older when determining energy needs. Categories of activity are defined in terms of walking equivalence (Table 10.4). Energy needs of toddlers and preschool-age children reflect the slowing growth velocity of children in this age group.

Dietary Reference Intakes (DRIs) Quantitative estimates of nutrient intakes, used as reference values for assessing the diets of healthy people. DRIs include Recommended Dietary Allowances (RDAs), Adequate Intakes (AI), Tolerable Upper Intake Levels (UL), and Estimated Average Requirements (EAR).

Recommended Dietary Allowances (RDAs) The average daily dietary intake levels sufficient to meet the nutrient requirements of nearly all (97–98 percent) healthy individuals in a population group. RDAs serve as goals for individuals.

Protein

Recommended Dietary Allowances (RDAs) have been established for protein (Table 10.5).[39] These recommendations are easily met with typical American diets as well as with vegetarian diets. Adequate energy intake to meet an individual child's needs has a protein-sparing effect; that is, with adequate energy intake, protein is used for growth and tissue repair rather than for energy. Ingestion of high-quality protein, such as milk and other animal products, lowers the amount of total protein needed in the diet to provide the essential amino acids.

Vitamins and Minerals

DRIs for vitamins and minerals have been established for the toddler and preschool-age child (Table 10.6).[41,42] Most children from birth to 5 years are meeting the targeted

Table 10.5 Dietary Reference Intakes for protein[39]

Age	RDA* g/kg/day
1–3 years	1.1 g/kg/day or 13 g/day*
4–8 years	0.95 g/kg/day or 19 g/day*

*RDA based on average weight for age (reference individual).

Source: From the National Academy of Sciences, Institute of Medicine, Food and Nutritional Board.

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Table 10.6 Dietary Reference Intakes for key nutrients for toddlers and preschoolers[41,42]

Age	Recommended Dietary Allowances		
	Iron (mg/day)	Zinc (mg/day)	Calcium (mg/day)
1–3 years	7	3	700
4–8 years	10	5	1,000

Source: National Academy of Sciences, Institute of Medicine, Food and Nutritional Board.

levels of consumption of most nutrients, except for iron, calcium, and zinc (refer to the "Recommended Versus Actual Food Intake" section).

10.5 Common Nutrition Problems

Iron-Deficiency Anemia

Iron deficiency and iron-deficiency **anemia** are prevalent nutrition problems among young children in the United States. A rapid growth rate coupled with frequently inadequate intake of dietary iron places toddlers, especially 9- to 18-month-olds, at the highest risk for iron deficiency.[43] According to the WHO, 6.1 percent of infants, toddlers, and preschool children ages 6 to 59 months are iron-deficient in the United States.[44] Iron-deficiency anemia is more common among low-income children and among Black and Hispanic American children.[3] The full impact of this nutrition problem is profound. Iron-deficiency anemia in young children appears to cause long-term delays in cognitive development and behavioral disturbances.[3,12,43,45] Healthy People 2030 objective NWS-16 is to reduce iron deficiency in young children to 6.3 percent for 1- to 2-year-olds (a significant improvement) and 4.3 percent for 3- to 4-year-olds (a 1 percentage point improvement).[7]

Iron deficiency can be defined as absent bone marrow iron stores, an increase in hemoglobin concentration of <1.0 g/dL after treatment with iron, or other abnormal lab values, such as serum ferritin concentration, the storage form of iron (Figure 10.2).[43] The definition of iron-deficiency anemia is less than the 5th percentile of the distribution of **hemoglobin** concentration or **hematocrit** in a healthy reference population. Age- and sex-specific cutoff values for anemia are derived from the NHANES III data. For children 1–2 years old, the diagnosis of anemia would be made if the hemoglobin concentration is <11.0 g/dL and hematocrit <32.9 percent. For children ages 2–5 years, a hemoglobin value <11.1 g/dL or hematocrit <33.0 percent is diagnostic of iron-deficiency anemia. Not all anemias are due to iron deficiency. Other causes of anemia include other nutritional deficiencies (such as folate or vitamin B_{12}), chronic inflammation, or recent or current infection.[3]

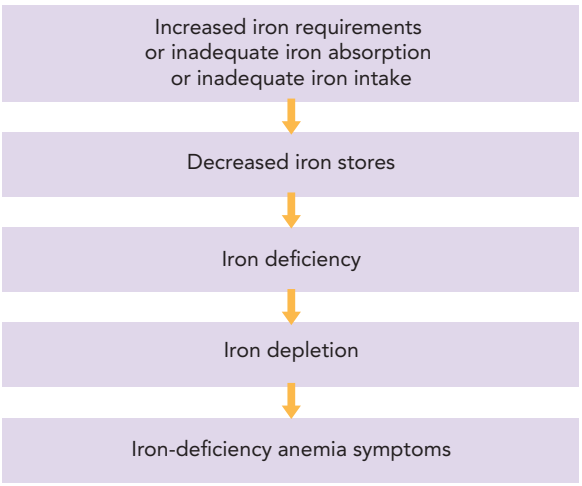


Figure 10.2 Progression of iron deficiency.

Preventing Iron Deficiency The CDC recommends that children 1–5 years of age drink no more than 24 oz of cow's milk, goat's milk, or soy milk each day because of the low iron content of these milks. Larger intakes of these milks may displace high-iron foods. For detecting iron deficiency, it is recommended that children at high risk for iron deficiency, such as low-income children, immigrants, and recently arrived refugee children, be tested for iron deficiency between the ages of 9 and 12 months, 6 months later, and then annually from ages 2 to 5 years. For children who are not at high risk for iron deficiency, selective screening of children at risk only is recommended by the CDC.[43,45] Children at risk include those who have a low-iron diet, consume more than 24 oz of milk per day, have limited access to food because of poverty or neglect, and have special health-care needs, such as an inborn error of metabolism or chronic illness. The AAP recommendations support universal screening for iron deficiency and iron-deficiency anemia at about 12 months of age and selective screening at any age in children who are at increased risk for iron deficiency or iron-deficiency anemia.[46]

Nutrition Intervention for Iron-Deficiency Anemia Treatment of iron-deficiency anemia includes supplementation with iron drops at a dose of 3 mg/kg/day, counseling

anemia A reduction below normal in the number of red blood cells per cubic mm in the quantity of hemoglobin, or in the volume of packed red cells per 100 mL of blood. This reduction occurs when the balance between blood loss and blood production is disturbed.

hemoglobin A protein that is the oxygen-carrying component of red blood cells. A decrease in hemoglobin concentration in red blood cells is a late indicator of iron deficiency.

hematocrit An indicator of the proportion of whole blood occupied by red blood cells. A decrease in hematocrit is a late indicator of iron deficiency.

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of parents or caretakers about diets that prevent iron deficiency, and repeat screening in 4 weeks. Dietary recommendations include increased consumption of lean meat, fish, and poultry and the inclusion of sources of vitamin C at mealtime to increase the absorption of nonmeat sources of iron.[12,45,46] An increase of >1 g/dL in hemoglobin concentration, or more than 3 percent in hematocrit, within 4 weeks of initiation of treatment confirms the diagnosis of iron deficiency. If the anemia is responsive to treatment, dietary counseling should be reinforced, and the iron treatment should be continued for 2 months. At that time, the hemoglobin and hematocrit should be rechecked, and the child should be reassessed in 6 months. If the hemoglobin and hematocrit do not increase after 4 weeks of iron treatment, further diagnostic tests are needed. Iron status will not improve with iron supplements if the cause of the anemia is not directly related to a need for iron.[43]

Dental Caries

Approximately 23 percent of children aged 2–5 years had decay in at least one primary or permanent tooth according to the CDC. This percentage reflects a 5-percentage-point decrease since 1999–2004.[47] During this same time period, 10 percent of children aged 3–5 years had at least one primary tooth with untreated dental decay reflecting a decrease in untreated dental decay by over half since 1999–2004. This issue occurs across all ethnic and racial groups, although it appears to be more prevalent in non-White children. Recent CDC data shows that untreated tooth decay in primary teeth among children aged 2–8 years was over 30 percent for Hispanic children.[47]

Healthy People 2030 Oral Health (OH) objectives OH-01 and OH-02 focus on reducing the proportion of children and adolescents with lifetime tooth decay.[7] A primary cause of dental decay is habitual use of a bottle or a no-spill training cup with milk or fruit juice at bedtime or throughout the day. Prolonged exposure of the teeth to these fluids can produce **early childhood caries (ECC)**, formerly called *nursing bottle caries* or *baby bottle tooth decay*.[48] The upper front teeth are most severely affected by decay, which is where fluids pool when toddlers fall asleep while drinking from a bottle. Toddlers with baby-bottle tooth decay are at increased risk for caries in the permanent teeth as the conditions that lead to ECC (poor diet and poor oral health habits) often continue into childhood.[48] Food sources of carbohydrates such as milk and fruit juice can have direct effects on dental caries development because *Streptococcus mutans,* the main type of bacteria that cause tooth decay, use carbohydrates for food. Bacteria present in the mouth excrete acid that causes the tooth decay.[49] Consequently, the more often and longer teeth are exposed to carbohydrates, the more the environment in the mouth is conducive to the development of tooth decay.[12] Foods containing carbohydrates that stick to the surface of the teeth, such as sticky candy like caramel, are strong caries promoters. Rinsing the mouth with water or brushing teeth to get rid of the carbohydrate stuck to teeth reduces caries formation. Young children allowed to "graze" or indiscriminately eat or drink throughout the day likely expose their teeth to carbohydrates for a longer period of time, which encourages bacteria proliferation and tooth decay. Crunchy, sweet foods such as carrot sticks and apple slices, when age-appropriate, are good choices for snacks because they are less likely to promote tooth decay than are sticky candies.

early childhood caries (ECC) The presence of one or more decayed (noncavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child less than 6 years of age.[48,49]

fluorosis Permanent white or brownish staining of the enamel of teeth caused by excessive ingestion of fluoride before teeth have erupted.[49]

Fluoride Children need a source of fluoride in the diet, preferably from fluoridated water and the use of fluoridated toothpaste. If the water supply is not adequately fluoridated, a fluoride supplement is recommended. The American Dental Association, the AAP, and the American Academy of Pediatric Dentistry have devised a fluoride supplementation schedule, which is based on the child's age and the fluoride content of the local water supply.[49,50] Children ages 6 months to 3 years need 0.25 mg of fluoride per day if their local water supply has less than 0.3 ppm of fluoride. Children 3–6 years of age need 0.5 mg fluoride per day if their water supply has less than 0.3 ppm, but only 0.25 mg fluoride per day if the local water has 0.3–0.6 ppm of fluoride.[49,50] Excessive fluoride supplementation, consumption of toothpaste with fluoride, and natural water supplies high in fluoride can cause **fluorosis**.

Although otherwise harmless, fluorosis produces permanent staining of the enamel of teeth, particularly permanent teeth. Because of the risk of fluorosis, fluoride supplements are only available by prescription. Few foods contain much fluoride, but fluoridated water used in beverages and food preparation does provide fluoride.

Constipation

Constipation, or hard and dry stools associated with painful bowel movements, is a common problem of young children. Sometimes *stool holding* develops when the child does not completely empty the rectum, which can lead to chronic overdistension so that eventually the child is retaining a large fecal mass.[51] Having a bowel movement can then become painful to the child, which leads to more stool holding, and a vicious cycle ensues. A pediatrician should manage the treatment of stool holding.

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Diets providing adequate fiber for age (Table 10.10) and appropriate amounts of fluid can help prevent constipation. Some of the best food sources of dietary fiber for toddlers and preschoolers are whole-grain breads and cereals, legumes, and fruits and vegetables appropriate for age. Too much fiber should be avoided, however. Young children easily develop diarrhea from high amounts of fiber, and high-fiber foods may displace other energy-dense foods and may decrease the bioavailability of some minerals, such as iron and calcium.[51]

Elevated Blood Lead Levels

High blood lead levels affect the functioning of many tissues in the body, including the brain, blood, and kidneys. Low-level exposure to lead is associated with decreases in IQ and impaired motor, behavioral, and physical abilities.[52,53] Elevated blood lead levels may decrease growth in young children.[52] In 2021, the CDC lowered the blood lead reference value from 5 to 3.5 µg/dL in children. This change allows for children with higher blood levels to receive more prompt services.[54] Approximately 2.5 percent of children ages 1–5 years old had lead blood levels over 3.5 µg/dL. However, some more recent research indicates that the physical and mental development of children may be affected by blood lead levels <10 µg/dL, and no safe level of blood lead in children has been established.[52–54]

Healthy People 2030 Environmental Health (EH) OB-04 is to reduce blood levels in children 1 to 5 years; most recent data is 3.31 µg/dL and the target is 1.18 µg/dL.[7] The major sources of lead exposure for young children are airborne lead, which has decreased in recent decades with the elimination of lead from gasoline and with the enforcement of industrial emissions standards, and leaded chips and dust, mainly from deteriorating lead paint.[53,54] Young children are particularly at risk for developing high levels of lead because, in exploring their environment, they enjoy putting things into their mouths. Depending on their surroundings, some of these objects may be high in lead. Damage caused by lead exposure may begin during pregnancy as lead is transported across the placenta to the fetus. Blood lead levels peak at about 2 years of age.[53–55] There are racial, ethnic, and socioeconomic disparities in children with high lead levels, with higher rates found in children whose parents income are below the federal poverty threshold, children of color, and recent immigrants.[53–55]

About 25 percent of children still live in housing with deteriorated lead-based paint.[41] Children living in housing built before 1978 are at increased risk of high lead levels because lead-based paint may have been used on these houses.[55,56] Lead-based paint chips taste sweet, tempting children to consume them. As the age of housing decreases nationally, so does the incidence of high lead levels in children.[7] Lead can enter the food supply through lead-soldered water pipes, contaminated water supplies, and from certain canned goods from other countries that contain lead-solder seals. Nonfood items containing lead include contaminated dirt and lead weights. Some parental occupations can be a source of lead. In these cases, parents should remove work clothing at work and wash work clothes separately. Other sources of lead include ceramic glazes and pewter used in some folk remedies and hobbies.[53–55]

The CDC published guidelines for screening children for lead poisoning in 1997, which was endorsed by the AAP.[53–56] The AAP advocates for a shift in focus from case identification and management to primary prevention. The CDC's recommendation includes a reference value of the 97.5th percentile of the NHANES generated blood lead levels distribution in children who are 1–5 years of age (currently 3.5 µg/dL) be used to identify those children with elevated blood lead levels.[57]

Federal policy requires lead screening of children who are enrolled in Medicaid.[12,53–57] Most local and state health departments have established recommendations for targeted screening based on the risk factors in the community. When indicated, lead screening should be obtained at 9–12 months of age and again around 24 months of age, when blood lead levels peak. Besides the age of the housing, other risk factors for high blood lead levels include living in poverty and having a sibling or playmate who has had high blood lead levels.

Nutritional Considerations Some of the risk factors for elevated blood lead levels are also the same risk factors for iron-deficiency anemia, such as young age, poor nutrition, and low socioeconomic status.[54,55] Iron-deficiency anemia is associated with pica, the ingestion of nonfood items, such as paint chips, which is a risk factor for lead ingestion. Some studies suggest that adequate iron intake may decrease lead absorption, which reinforces the benefits of treating iron-deficiency anemia in young children.[56] Some studies suggest that vitamin C may increase lead excretion. Although the evidence is not strong enough to recommend for or against vitamin C supplementation for children with elevated blood lead levels, it is important for young children to have sources of vitamin C in their diets for the prevention of iron deficiency.[43,56] There is good evidence that dietary calcium competitively decreases lead absorption, but there is no clinical evidence that supplementing calcium beyond the adequate intake for age has a clinical effect on elevated blood lead levels.[56] Although animal and epidemiological studies point to an association between dietary fat intake and elevated blood lead levels, low-fat diets are not recommended for the treatment of elevated blood lead levels in young children. No clinical data exist showing the benefits, and fat is an important source of calories for young children.[53,56] To summarize, eliminating sources of lead in the child's environment is the most important step toward eliminating elevated blood lead levels in children. In addition, preventing iron deficiency and promoting a well-balanced diet that includes good sources of calcium and vitamin C help prevent this problem in young children.

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Food Security

Healthy People 2030 objective NWS-02 is to eliminate very low **food security** among children.[7]

In 2021, 10.2 percent of U.S. households experiencing food insecurity—meaning that they had difficulty at some time during the year providing enough nutritionally adequate food for all their members because of a lack of resources. That level is slightly decreased from 2020, and significantly decreased from 14.0 percent in 2014. The prevalence of food insecurity is higher in households headed by African American or Black, non-Latinx Americans (19.8 percent), or Latinx Americans (16.2 percent), highlighting racial-ethnic health disparities.[58–60] During the COVID-19 pandemic, food insecurity rose in single-parent households, households with children, and among Hispanic and Black households.[60] Fifty-five percent of households experiencing food insecurity in 2020 reported participating in one or more of the three largest federal food and nutrition assistance programs.[60] During the COVID-19 pandemic, the U.S. government added extra benefits to the Supplemental Nutrition Assistance Program (SNAP).

Food security is particularly important for young children because of their high nutrient needs for growth and development. Young children are a vulnerable group because they must depend on their parents and caretakers to supply them with adequate access to food. It appears that children who are hungry and have multiple experiences with food insufficiency are more likely to exhibit behavioral, emotional, and academic problems as compared to other children who do not experience hunger repeatedly.[60]

Food Safety

Young children are especially vulnerable to foodborne illnesses because they can become ill from smaller doses of organisms. Key foodborne pathogens include *Campylobacter* species and *Salmonella* species, which are the most frequently reported foodborne illnesses in the United States, and the pathogen *E. coli 0157:H7,* which is the most commonly identified *Shiga* toxin–producing *E. coli* (STEC) in North America.[61] The highest rate of *Campylobacter* species infections is seen in children under age 1.[61] *Campylobacter* is transmitted by handling raw poultry, eating undercooked poultry, drinking raw milk or nonchlorinated water, or handling infected animal or human feces.[61] The most common cause of *Salmonella* food poisoning is consumption of foods containing undercooked or raw eggs, such as raw cookie dough containing eggs. Children younger than 10 years of age account for a disproportionate percent of cases of *E. coli*–related illness. It is a serious disease and can cause bloody diarrhea and **hemolytic uremic syndrome (HUS),** which can be fatal. Outbreaks of *E. coli* have been associated with ingestion of contaminated, undercooked hamburger meat, unpasteurized apple cider and juice, and unpasteurized milk. Employing proper food storage and preparation techniques at home, in child care centers, and in retail food establishments is essential for decreasing the incidence of foodborne illnesses in young children. Contamination of food products can occur at any point along the way from production to consumption. Therefore, risk reduction and controls can be targeted at various steps in food processing. One food safety education program, called FightBAC™, was developed by the Partnership for Food Safety Education, a public–private partnership of industry, state and consumer organizations, and government agencies, including the CDC and EPA. FightBAC has four food-safety practice messages:[62]

- Clean: Wash hands and surfaces often.
- Separate: Don't cross-contaminate.
- Cook: Cook to proper temperatures.
- Chill: Refrigerate promptly.

The *Dietary Guidelines for Americans* include a recommendation for following food safety principles when preparing and eating foods to reduce the risk of foodborne illnesses.[63]

The AAP endorses the consumption of only pasteurized milk and milk products for pregnant women, infants, and children and a ban on the sale of raw or unpasteurized milk and milk products throughout the United States. This ban includes the sale of certain raw milk cheeses, such as fresh cheeses, soft cheeses, and soft-ripened cheeses.[61]

food security Access at all times to a sufficient supply of safe, nutritious foods.

hemolytic uremic syndrome (HUS) A serious, sometimes fatal complication associated with illness caused by *E. coli 0157:H7,* which occurs primarily in children under the age of 10 years. HUS is characterized by renal failure, hemolytic anemia, and a severe decrease in platelet count.[61]

obesity BMI-for-age greater than or equal to the 95th percentile.[10,65]

overweight Body mass index-for-age between the 85th and 94th percentiles.[10,64]

10.6 Prevention of Nutrition-Related Disorders

The prevalence of children and adolescents with **obesity** or who are **overweight** in the United States continues to increase and represents a major public health problem.[64,65] High-energy, high-fat diets, coupled with sedentary lifestyles, are thought to be major contributors to the increase in weight. Cardiovascular disease, a major cause of death and morbidity in the United States today, is also thought to be influenced by diets and sedentary lifestyles. Food habits, preferences, and behaviors established during the toddler and preschool ages logically influence dietary habits later in

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life and subsequent health status. Behaviors associated with risk factors for cardiovascular disease, including dietary habits, physical activity behaviors, and the use of tobacco, can be acquired in childhood.[63] The American Heart Association (AHA) strongly advocates that primary prevention of atherosclerotic disease begin in childhood.[63] Families are encouraged to adopt dietary and exercise patterns that promote a healthy lifestyle.

Toddlers and Pre-schoolers Who Have Higher Weight and Those with Obesity

Overweight and obesity continue to remain an issue in the toddler and preschool population. During 2017–2020, 19.7 percent of children and adolescents (14.7 million) ages 2 to 19 years old met the criteria for obesity. The prevalence of obese children 2 to 5 years old during this same time period was 12.7 percent and 20.7 percent for children 6 to 11 years old.[66,67]

No significant difference in the prevalence of overweight and obesity was found between male and female children, but differences do exist by race/ethnicity. Obesity rates were lowest in non-Hispanic Asian children (9.0 percent) compared to non-Hispanic White children (16.6 percent), non-Hispanic Black children (24.8 percent), and Hispanic children (26.2 percent).[67] Obesity disproportionally affects children from low-income families.

Obesity is a multifaceted problem that is difficult to treat, making prevention the preferred approach. The American Medical Association (AMA) in collaboration with the U.S. Department of Health and Human Services (DHHS) convened a multidisciplinary committee of experts to develop evidence-based recommendations on the assessment, prevention, and treatment of child and youth overweight and obesity. The expert committee's work culminated in the publication of four articles: a summary report and three separate articles on the topics of assessment, prevention, and treatment, which were endorsed by 12 professional organizations including the AAP, the Academy of Nutrition and Dietetics (formerly the American Dietetic Association), and the AHA.[10,37,65,68]

Assessment of Overweight and Obesity

Body mass index-for-age percentile is recommended as the screening tool for assessment of pediatric overweight and obesity. A BMI-for-age percentile of 85th to 94th is defined as *overweight*, and a BMI-for-age ≥95th is defined as *obesity*.[10,65] BMI normative values are not available for children less than 2 years of age. For these young children, a weight-for-length >95th percentile is considered to be overweight.[10]

During the preschool years, a decrease in body mass index (BMI), or weight-for-height squared [wt(kg)/ht(m)^2], is a normal part of growth and development. BMI usually reaches its lowest point at approximately 4–6 years of age and then increases gradually in the period called **BMI rebound**.[66] Early BMI rebound in children increases the risk of adult obesity.[69,70]

Other essential components of assessment include (1) evaluation of the child's medical risk, including parental obesity, family medical history, and evaluation of weight-related problems such as sleep and respiratory problems, and (2) behavior risk assessment, including dietary and physical activity behaviors.[10,65,68] Another aspect of the behavioral assessment is evaluation of the child's and/or family's attitudes toward and capacity to change some behaviors.[10,65]

Prevention of Overweight and Obesity

All children should be targeted for prevention of overweight and obesity from birth by instituting lifestyle behaviors that prevent obesity.[10,37,38] The expert panel has identified the following target behaviors in the prevention of pediatric overweight and obesity based on available evidence and on analysis of available data and expertise:[10,37,38]

- Limiting sugar-sweetened beverages
- Encouraging consumption of recommended amounts of fruits and vegetables
- Limiting television and other screen time by allowing a maximum of 2 hours of screen time per day and removing televisions and other screens from children's bedrooms
- Eating breakfast every day
- Limiting eating out at restaurants, especially fast-food restaurants
- Limiting portion sizes
- Eating a diet rich in calcium
- Eating a diet high in fiber (Refer to the "Fiber" section.)
- Eating a diet that follows the Dietary Reference Intakes for macronutrients (carbohydrates, protein, and fat)
- Promoting moderate to vigorous physical activity for at least 60 minutes each day
- Limiting energy-dense foods

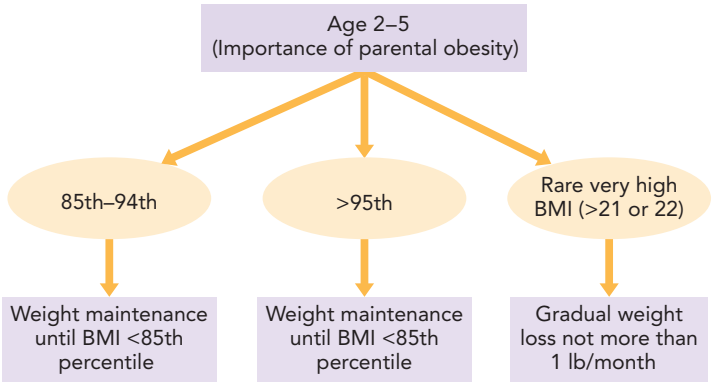
Parenting techniques, such as finding reasons to praise the child's behavior but never using food as a reward, foster the development of healthy eating behaviors in children and help children to self-regulate food intake (refer to the "Food Preference Development, Appetite, and Satiety" section).

Treatment of Overweight and Obesity Expert Committee: Recommendations

The goal of overweight and obesity treatment is the improvement of long-term physical health through permanent healthy lifestyle habits and behavior modification.[10,66,68] Improvement is measured by a decrease in BMI-for-age percentile, but this is difficult to see in the short term.

BMI rebound A normal increase in body mass index that occurs after BMI declines and reaches its lowest point at 4–6 years of age.[68]

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Note: In the short term (<3 mos), in general, weight changes may be easier parameter to measure

Figure 10.3 Suggested weight changes in staged treatment of pediatric obesity.

Sources: Based on data from Spear, B. A., et al. Recommendations for treatment of child and adolescent overweight and obesity. *Pediatrics*. 2007; 120:S254–S288;[68] and Browne, N. T., & Cuda, S. E. Nutritional and activity recommendations for the child with normal weight, overweight, and obesity with consideration of food insecurity: An Obesity Medical Association (OMA) Clinical Practice Statement 2022. *Obesity Pillars*. 2022 Jun 1; 2:100012.

Weight measurements on a regular basis can be used to measure progress in the short term. Maintaining weight while gaining height can be the best treatment for children with obesity between the ages of 2 and 5. This approach allows the child with obesity to "grow into his or her weight" and to lower BMI. If weight loss does occur, it should not exceed 1 lb per month in children this age, whether they fall into the overweight or obese category.[10,66,68]

The expert committee recommends a staged approach to pediatric overweight and obesity treatment (Figure 10.3).

Stage 1: Prevention Plus This stage focuses on the behaviors identified in the prevention section. The healthcare provider can identify dietary and physical activity behaviors in the individual child and family that would be appropriate to target and, using motivational interviewing techniques, can assist the family in making appropriate changes. Targeted behaviors can be achieved in steps, with the ultimate goal being an improvement in BMI-for-age percentile. This stage involves more frequent follow-up based on the individual child and family's needs.[10,66,68]

Stage 2: Structured Weight Management (SWM) This stage of treatment is more structured and requires more frequent follow-up. Some of the elements of the Structured Weight Management Plan include a planned diet or daily eating plan, further reduction of screen time to less than 1 hour per day, and planned supervised physical activity or active play for 60 minutes per day. This stage includes monitoring behavior through the use of logs and planned reinforcement for achieving targeted behaviors. A registered dietitian or a clinician who has received additional training is required to work with the child and her family on an eating plan. Staff members also need to be trained in motivational interviewing. Depending on individualized needs, a counselor may need to be involved to address parenting and caretaker skills or to help resolve family issues that may be barriers to healthy lifestyle behaviors. Monthly visits are recommended, some of which may be group sessions.[10,66,68]

Stage 3: Comprehensive Multidisciplinary Intervention In this stage, the intensity of behavior change is increased and a multidisciplinary team, including a registered dietitian, an exercise specialist, a behavioral counselor, and the primary care provider, is needed to maximize support for behavior change. Weekly visits are recommended for a minimum of 8–12 weeks, some of which may be group visits. This stage is a structured program in behavior modification that includes, at a minimum, food monitoring, short-term diet resulting in a negative energy balance, and physical activity goal setting. Parents are involved in behavior modification for their child and in parental training for improving the home environment. There is a systematic evaluation of body measurements, diet, and physical activity at specified time intervals.[10,66]

Stage 4: Tertiary Care Intervention This stage is offered to adolescents experiencing obesity with a history of failed interventions. This stage is not appropriate for a toddler or preschool-aged child experiencing obesity.[10,66]

Dietary Guidelines for Americans 2020–2025

The *Dietary Guidelines for Americans 2020–2025* emphasize the importance of maintaining appropriate calorie balance during each stage of life, including childhood, to manage weight and support the principles of pediatric weight management endorsed by the expert committee. Reducing weight at this young age is tricky because sufficient nutrients must be provided for children to reach their full height potential and to remain healthy.

Nutrition and Prevention of Cardiovascular Disease in Toddlers and Preschoolers

Heart disease is the number-one cause of death in the United States today. A leading risk factor for cardiovascular disease, which includes diseases of the heart and blood

heart disease The leading cause of death and a common cause of illness and disability in the United States. Coronary heart disease is the principal form of heart disease and is caused by buildup of cholesterol deposits in the coronary arteries, which feed the heart.

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vessels, is elevated levels of **LDL cholesterol.** Children with **familial hyperlipidemias** and obese children can have high levels of LDL cholesterol. High intakes of saturated fat, ***trans* fatty acids**, and, to a lesser extent, dietary cholesterol, elevate LDL cholesterol levels in children and adults alike. Other nutrition-related risk factors for cardiovascular disease include high triglyceride levels and high BMI.[63] Fatty streaks, which can be precursors to the buildup of fat deposits in blood vessels, have been found in the arteries of young children. Some experts believe that these streaks can represent the beginning of **atherosclerosis** and cardiovascular disease.[63] Guidelines for promoting cardiovascular health and risk reduction in children have been published by several professional organizations and health agencies.

The AHA has published guidelines for the primary prevention of atherosclerotic cardiovascular disease beginning in childhood.[71] In these guidelines, the AHA recommends that all children be screened for risk factors of developing future cardiovascular disease. Furthermore, the AHA recommends that all children have an overall healthy eating pattern while maintaining an appropriate body weight, desirable lipid profile, and desirable blood pressure. Avoidance of smoking is encouraged as well as daily physical activity and the reduction of sedentary time.[71] Like the obesity expert panel, the AHA has also published strategies for implementing the recommended guidelines that employ behavior change theory and motivational interviewing.[71] The AHA has published dietary recommendations for children, which have been endorsed by the AAP and that are consistent with the U.S. *Dietary Guidelines*.[72,73] The recommended diet includes fruits and vegetables, whole-grain breads and cereals, the use of nonfat or low-fat dairy products, and two servings of fish weekly. The use of vegetable oils and soft margarines low in saturated fat and *trans* fatty acids instead of butter or most other animal fats is recommended. The recommendations also include reducing the intake of sugar-sweetened beverages and foods and reducing salt intake.[74,75] For children ages 2–3 years, 30–35 percent of total energy from fat is recommended. For children 4 years of age or older, the recommendation is 25–35 percent of total energy from fat.[74,75] A *trans* fatty acid intake of less than 1 percent of total calories is also recommended.[74,75] Studies have shown that such dietary restrictions are safe and effective for reducing risk factors in childhood without negatively impacting growth.[76]

According to the new DRIs,[39] the acceptable macronutrient distribution ranges (AMDRs) for fat are 30–40 percent for children 1–3 years and 25–35 percent for children 4–18 years. No specific recommendations for total fat per day in the diets of young children have been made. Adequate intake levels for the essential fatty acids, linoleic acid and alpha-linolenic acid, have been determined.[39]

The AAP endorses the population approach to a healthful diet for all children older than 2 years of age. Children with a positive family history of dyslipidemia or premature cardiovascular disease should be screened for high lipid levels. The individual approach to screening with a fasting lipid profile is also recommended for children whose family history is not known and for those children with other cardiovascular risk factors such as overweight/obesity, hypertension, or diabetes mellitus. Screening for these children should take place after 2 years of age, but not later than 10 years of age.[77]

Dietary recommendations are different for children who are at increased risk of developing premature cardiovascular disease or are found to have high lipid levels. These children need periodic screening for blood cholesterol levels and close follow-up. If LDL cholesterol levels are high, restriction of total calories from saturated fat to less than 7 percent and of dietary cholesterol to no more than 200 mg per day is recommended. These children need to be closely monitored by a physician and registered dietitian.[63]

More recently, the National Heart, Lung, and Blood Institute (NHLBI) convened a panel of experts to develop evidence-based cardiovascular health guidelines for pediatric care providers, which address all major cardiovascular risk factors simultaneously.[78] For the most part, this expert panel's findings reinforce the recommendations of the AHA, the AAP, and the *Dietary Guidelines for Americans*. The panel recommends a Cardiovascular Health Integrated Lifestyle Diet (CHILD-1) for children with identified dyslipidemia and other risk factors such as overweight and obesity as well as for children with a positive family medical history of early cardiovascular disease or risk factors such as obesity or primary hypertension (Table 10.7).[79,80]

Vitamin and Mineral Supplements

Children who consume a variety of basic foods can meet all of their nutrient needs without vitamin or mineral supplements. Eating a diet of a variety of foods is the preferred way to get needed nutrients because foods contain many other substances, such as phytochemicals, in addition to nutrients that benefit health.

LDL cholesterol Low-density lipoprotein cholesterol, the lipid most associated with atherosclerotic disease. Diets high in saturated fat, *trans* fatty acids, and dietary cholesterol have been shown to increase LDL cholesterol levels.

familial hyperlipidemia A condition that is hereditary and results in high levels of serum cholesterol and other lipids.

***trans* fatty acids** Fatty acids that have unusual shapes resulting from the hydrogenation of polyunsaturated fatty acids. *Trans* fatty acids also occur naturally in small amounts in foods such as dairy products and beef.

atherosclerosis A type of hardening of the arteries in which cholesterol is deposited in the arteries. These deposits narrow the coronary arteries and may reduce the flow of blood to the heart.

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Table 10.7 Evidenced-based recommendations for diet and nutrition (for cardiovascular health)[79]

CHILD-1 (Cardiovascular Health Integrated Lifestyle Diet for Children with Risk Factors)	
12 to 24 months	Transition to reduced-fat unflavored cow's milk Limit/avoid sugar-sweetened beverage intake, encourage water Transition to table food with: • Total fat 30% of daily kcal/Estimated Energy Requirement (EER) • Saturated fat 8–10% of daily kcal/EER • Avoiding *trans* fat as much as possible • Monounsaturated and polyunsaturated fat up to 20% of daily kcal/EER • Cholesterol <300 mg/day
2 to 10 years	Primary beverage fat-free unflavored milk Limit/avoid sugar-sweetened beverages, encourage water Fat content: • Total fat 25–30% of daily kcal/EER • Saturated fat 8–10% of daily kcal/EER • Avoid *trans* fats as much as possible • Monounsaturated and polyunsaturated fat up to 20% of daily kcal/EER • Cholesterol <300 mg/day Encourage high dietary fiber intake from foods
CHILD-2-LDL (Dietary Management of Elevated LDL Cholesterol)	
2 to 21 years	Refer to a registered dietitian for family medical nutrition therapy 25–30% of calories from fat <7% of calories from saturated fat ≈10% from monounsaturated fat <200 mg/day of cholesterol Avoid *trans* fats as much as possible
CHILD-2-TG (Dietary Management of Elevated Triglycerides or Non-HDL Cholesterol)	
2 to 21 years	Refer to a registered dietitian for family medical nutrition therapy 25–30% of calories from fat ≤7% of calories from saturated fat ≈10% from monounsaturated fat <200 mg/day of cholesterol Avoid *trans* fats as much as possible Decrease sugar intake • Replace simple with complex carbohydrates • No sugar-sweetened beverages Increase dietary fish to increase omega-3 fatty acids

Source: *Pediatrics*, 2011;128 (December), Supplement 5, Nutrition and Diet section, pp. S220–S222, and Table 9–8, p. S243.

The AAP recommends vitamin and mineral supplementation for children who are at high risk of developing or have one or more nutrient deficiencies.[12] Children at risk of nutrient deficiency according to the AAP include those:

1. With anorexia or an inadequate appetite or who follow fad diets
2. With chronic disease
3. Within families lacking economic or social necessities or who suffer from neglect or abuse
4. Who participate in a dietary program for managing obesity
5. Who consume a vegetarian diet without adequate intake of dairy products
6. With failure to thrive

Despite these recommendations, survey data indicate that young children are major users of supplements.[79,81] NHANES 2017–2020 showed 34.8 percent of children and adolescents in the last 30 days consumed at least one dietary supplement. Approximately 25.2 percent of toddlers ages 1–2 years and 45.2 percent ages 2 to 5 years have used one or more dietary supplements.[82] The most common type of supplement used by children was multivitamins and multiminerals.[82,83] Children most likely to receive supplements were underweight or at risk for underweight.[82,83] Considering characteristics of families who give their children supplements, such as a greater household income, the children most likely to receive a supplement are those at low risk of developing nutrient deficiencies—in other words, children who would most likely benefit from supplements are less likely to receive them.

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If given to children, vitamin and mineral supplement doses should not exceed the DRI for age. Parents and caretakers should be warned against giving high amounts of vitamins and minerals to children, particularly vitamins A (retinol) and D. The **Tolerable Upper Intake Levels** shown in the DRI tables should serve as a guide to excessive levels of nutrient intake from fortified foods and supplements.

Herbal Supplements

The use of herbal remedies for various disorders is increasing in the United States today, as is the use of complementary and alternative medicine practices in general. Parents and caretakers who take herbs are likely to give these products to their children. In one survey with a 59.4 percent response rate, participants of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in the states of Kansas and Wisconsin indicated herbal use by caregivers, children, or both in nearly half of the returned surveys. Herb use was statistically greater among Latinx children than non-Latinx children, 48.4 percent versus 31.4 percent, respectively. Of the 1,363 children reported to use herbs, 820 of them were younger than 5 years of age.[83]

Few definitive studies exist on the effectiveness of these substances in preventing disease and promoting health in adults, much less in children. In spite of the lack of scientific evidence, anecdotal reports of benefits abound. However, some reports have linked herbal preparations to adverse effects.[84] Information on herb use should be obtained during the nutrition assessment of a child to rule out herbs as a source of health problems. Currently, herbal supplements are not regulated and using the products can lead to uncertain results. Parents and guardians should be advised of the potential risks of herbal therapies and the need for close monitoring of their child if they choose to give herbs to their child. The National Institutes of Health's (NIH) National Center for Complementary and Alternative Medicine (NCCAM) website (www.nccam.nih.gov) provides reports on the known safety and effectiveness of various herbal remedies and alternative medical practices.

10.7 Dietary and Physical Activity Recommendations

> "... Children ages 2 to 11 years should achieve optimal physical and cognitive development, attain a healthy weight, enjoy food, and reduce the risk of chronic disease through appropriate eating habits and participation in regular physical activity."[85]
>
> —The Academy of Nutrition and Dietetics (formerly the American Dietetic Association)

Taking into consideration the energy and nutrient needs of young children and the common nutritional problems and concerns of this age group, it is easy to understand the importance of dietary recommendations for toddlers and preschoolers. A primary recommendation is that young children eat a variety of foods. This recommendation is more easily achieved if healthful food preferences and eating habits are acquired during the early years. Food preferences in conjunction with food availability form the foundation of the child's diet. Limited food selection, therefore, will influence the adequacy of the child's diet by decreasing variety. Parents and caretakers cannot expect a child to "do as I say, but not as I do." Nutrition education aimed at the adults in the child's life becomes as important as nutrition education directed at the child, if not more so.

Dietary recommendations have been developed and disseminated by the federal government and professional organizations. Two sets of guidelines for young children's diets are available: the *Dietary Guidelines for Americans 2020–2025* and MyPlate.[13,63] Recommendations for energy and nutrient intake are represented in the DRIs.

Dietary Guidelines for Americans 2020–2025

The *Dietary Guidelines for Americans 2020–2025* (discussed in Chapter 1) include some key recommendations for specific population groups, including children. The guidelines emphasize that children should be offered a variety of foods, including grain products (at least half of which should be whole grains), vegetables (especially dark-green and red and orange vegetables) and whole fruits, and low-fat dairy products (Table 10.8).[63]

The guidelines also recommend reducing the amount of sugar-sweetened beverages and added sugar in children's diets. Children 2–8 years should drink 2 cups per day of fat-free or

Table 10.8 Tips for offering a variety of foods[13]

• Mix it up. Change your typical foods. Try something new with your family. Here are just a few ideas: fresh pineapple, green peppers, low-fat cheese, canned salmon, or a whole-wheat pita with hummus.
• Let your child choose a new vegetable to add to soup. Only an adult should heat and stir hot soup.
• Add different ingredients to your typical salads. Try adding mango, Swiss chard, or tuna to your green salad.
• Vary the cereals, types of bread, and sandwich fillings you buy week to week.
• Add fruit to your preschooler's breakfast by using it to top cereal.
• Put rinsed and cut fruits and vegetables, in a bag or bowl, on a shelf in your refrigerator where your child can see them.

Source: U.S. Department of Agriculture. Develop healthy eating habits: Offer a variety of foods. www.myplate.gov.

Tolerable Upper Intake Levels Highest level of daily nutrient intake that is likely to pose no risk of adverse health effects to almost all individuals in the general population; gives levels of intake that may result in adverse effects if exceeded on a regular basis.

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low-fat milk or equivalent milk products. With regard to fats, the guidelines recommend keeping the total fat intake between 30 and 40 percent of calories for children 1–3 years of age and between 25 and 35 percent of calories for children and adolescents 4–18 years of age. Fat is an important source of calories, fat-soluble vitamins, and essential fatty acids for young children. Most fats in children's diets should come from sources of polyunsaturated and monounsaturated fatty acids, such as fish, nuts, and vegetable oils. Some fish may contain higher levels of mercury that may harm a young child's developing nervous system. The Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA) advise that young children should eat fish and shellfish that are lower in mercury. Fish that are highest in mercury are tilefish from the Gulf of Mexico, shark, swordfish, and king mackerel. Updated advice from the FDA and EPA recommends these fish be avoided in young children.[86] Information about the mercury content of fish in a specific area can be obtained from the FDA (www.fda.gov).

The guidelines also recommend that beans, lean meats, and poultry be added as appropriate for the child. Foods high in solid fats and added sugar (SoFAS), such as candy, cookies, and cakes, should be limited in children's diets. The *Dietary Guidelines* also emphasize the importance of parents modeling this type of diet for their children, or encouraging them "to do as I say and as I do." The guidelines emphasize the importance of physical activity. Although no specific quantitative recommendation for physical activity has been set for children 2–5 years of age, young children should play actively several times each day.[62] It is important that parents and caretakers model for their children a lifestyle that includes a varied diet and regular physical activity. As mentioned previously, the AMA dietary recommendations are consistent with the U.S. *Dietary Guidelines*. The AHA places special emphasis on adequate intake of omega-3 fatty acids and recommends introducing and regularly serving fish as an entrée to children. The recommendations also emphasize physical activity and balancing intake with physical activity.[63,74,75]

MyPlate

The U.S. Department of Agriculture (USDA) has developed MyPlate, which replaces the MyPyramid and MyPyramid for Kids, as an education tool for consumers to employ the *Dietary Guidelines for Americans*.[13,62] The color-coded MyPlate icon, which is depicted in Chapter 1, encourages the consumption of a variety of foods from five food groups, using a place setting (a familiar mealtime visual), and is based on the *Dietary Guidelines for Americans 2020–2025* (Figure 10.4).[62] Selected messages of MyPlate.gov, a website that provides practical information for building healthier diets, include making half the plate fruits and vegetables, making at least half of grains whole grains, switching to fat-free or low-fat milk, choosing foods lower in sodium, and drinking water instead of sugary drinks (Table 10.9).[13] Age-appropriate physical activity is also encouraged (Figure 10.4).

Recommendations for Intake of Iron, Fiber, Fat, and Calcium

Adequate iron intake is necessary to prevent iron deficiency and iron-deficiency anemia in toddlers and preschoolers. Appropriate fiber intake is needed to prevent constipation and may provide long-term disease prevention. Fat is an important source of calories, essential fatty acids, and fat-soluble vitamins in young children's diets. Adequate calcium intake is important for children to achieve peak bone mass.

Iron Adequate iron intake is important in this age group to prevent iron deficiency. Good sources of dietary iron can be found in Chapter 1, Table 1.14. Meats, which are good sources of iron, can be ground or chopped to make them easier for toddlers to chew. Fortified breakfast cereals and dried beans and peas are also good sources of iron.

Milk products and iron-fortified commercial formulas specialized for toddlers are available. Healthy children who consume a variety of foods, and whose milk intake is less than 24 oz daily, obtain adequate iron without these special products. Other commercial beverages being marketed to parents and guardians include



Courtesy of Food and Health Communications

Figure 10.4 MyPlate for kids.[11]

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Table 10.9 MyPlate—Individual plan for a 4-year-old boy who is physically active for at least 60 minutes every day[13]

Calories	Allowance		
Total Calories	1,600 per day		
Empty Calories*	≤121 per day		
Food Group	**Food Group Amount**	**"What Counts As . . ."**	**Tips**
Grains	5 oz per day	1 oz of grains	Tips
• Whole Grains	• ≥3 oz per day	• 1 slice of bread (1 oz) • ½ cup cooked pasta, rice, or cereal • 1 oz uncooked pasta or rice • 1 tortilla (6-in. diameter) • 1 pancake (5-in. diameter) • 1 oz ready-to-eat cereal (about 1 cup cereal flakes)	• Eat at least half of all grains as whole grains. • Substitute whole-grain choices for refined grains in breakfast cereals, breads, crackers, rice, and pasta. • Check product labels—is a grain with "whole" before its name listed first on the ingredients list?
Vegetables	2 cup(s) per day	1 cup of vegetables	Tips
• Dark green • Red and orange • Beans and peas • Starchy • Other	• 1½ cup(s) per week • 4 cup(s) per week • 1 cup(s) per week • 4 cup(s) per week • 3½ cup(s) per week	• 1 cup raw or cooked vegetables • 1 cup 100% vegetable juice • 2 cups leafy salad greens	• Include vegetables in meals and in snacks. Fresh, frozen, and canned vegetables all count. • Add dark-green, red, and orange vegetables to main and side dishes. • Use dark leafy greens to make salads. • Beans and peas are a great source of fiber. Add beans or peas to salads, soups, and side dishes, or serve as a main dish.
Fruits	1½ cup(s) per day	1 cup of fruit	Tips
		• 1 cup raw or cooked fruit • 1 cup 100% fruit juice • ½ cup dried fruit	• Select fresh, frozen, canned, and dried fruit more often than juice; select 100% fruit juice when choosing juice. • Enjoy a wide variety of fruits, and maximize taste and freshness, by adapting your choices to what's in season. • Use fruit as snacks, salads, or desserts.
Dairy	2½ cup(s) per day	1 cup of dairy	Tips
		• 1 cup milk • 1 cup fortified soymilk (soy beverage) • 1 cup yogurt • 1½ oz natural cheese (e.g., cheddar) • 2 oz processed cheese (e.g., American)	• Drink fat-free (skim) or low-fat (1%) milk. • Choose fat-free or low-fat milk or yogurt more often than cheese. • When selecting cheese, choose low-fat or reduced-fat versions.
Protein Foods	5 oz per day	1 oz of protein foods	Tips
• Seafood	• 8 oz per week	• 1 oz lean meat, poultry, seafood • 1 egg • 1 Tbsp peanut butter • ½ oz nuts or seeds • ¼ cup cooked beans or peas	• Eat a variety of foods from the protein foods group each week. • Eat seafood in place of meat or poultry twice a week. • Select lean meat and poultry. Trim or drain fat from meat and remove poultry skin.
Oils	5 tsp per day	1 tsp of oil	Tips
		• 1 tsp vegetable oil (e.g., canola, corn, olive, soybean) • 1½ tsp mayonnaise • 2 tsp tub margarine • 2 tsp French dressing	• Choose soft margarines with zero *trans* fats made from liquid vegetable oil, rather than stick margarine or butter. • Use vegetable oils (olive, canola, corn, soybean, peanut, safflower, sunflower) rather than solid fats (butter, shortening). • Replace solid fats with oils, rather than adding oil to the diet. Oils are a concentrated source of calories, so use oils in small amounts.

*Calories from food components such as added sugars and solid fats that provide little nutritional value. Empty calories are part of total calories.

Source: www.myplate.gov/.

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formulas that were originally designed for children with illnesses or who had to be fed complete nutrition through a feeding tube.

Fiber Ample dietary fiber intake has been associated with the prevention of heart disease, certain cancers, diabetes, and hypertension in adults. Whether fiber helps prevent these problems as young children become adults is not known, but it is clear that fiber in a child's diet helps prevent constipation and is part of a healthy diet (Table 10.10).[39] Excessive fiber (defined as the child's age plus 15 g) can be detrimental, however, because high-fiber diets have the potential of reducing the energy density of the diet, which could impact growth.[87] High-fiber diets could also impact the bioavailability of some minerals, such as iron and calcium.

Including fruits, vegetables, and whole-grain breads and cereal products in the diet can increase the dietary fiber intake of children. Those who meet the recommendation consume more breads and cereals, fruits, vegetables, legumes, nuts, and seeds than those who do not. Children with adequate fiber intake tend to have lower intakes of fat and cholesterol, and higher intakes of vitamins A and E, folate, magnesium, and iron, than do those children who have low dietary fiber intakes.[88,89]

Fat An appropriate amount of fat in a young child's diet can be achieved by employing the principles of the *Dietary Guidelines for Americans* and MyPlate that promote a diet of whole-grain breads and cereals, beans and peas, fruits and vegetables, low-fat dairy products after 2 years of age, and lean meats.[13,62] Foods high in fat are used sparingly, especially foods high in saturated fat and *trans* fatty acids. However, an appropriate amount of dietary fat is necessary to meet children's needs for energy, essential fatty acids, and fat-soluble vitamins. As discussed in Chapter 1, good sources of the essential fatty acid linoleic acid are peanut, canola, corn, safflower, and other vegetable oils. Flaxseed, soy, and canola oils are good sources of the essential fatty acid alpha-linolenic acid.

Fat-Soluble Vitamins

It is important to include sources of fat-soluble vitamins in the diets of young children. Good sources of vitamin A include whole eggs and dairy products. Sources of vitamin D include exposure to sunlight and vitamin D–fortified milk. The AAP recommends a daily intake of 400 IU of vitamin D for all healthy children, while the DRIs for vitamin D were increased to 600 Ius for children 1–8 years of age with the revision of the DRIs for calcium and vitamin D in 2010.[41,90,91] Corn, soybean, and safflower oils are excellent sources of vitamin E. Vitamin K is widely distributed in both animal and plant foods.

Table 10.10 Adequate intake of total fiber for children[39]

1–3 years of age	19 g/day of total fiber
4–8 years of age	25 g/day of total fiber

Source: Data from National Academy Press. Table created by Nancy H. Wooldridge.

Calcium Adequate calcium intake in childhood affects peak bone mass. A high peak bone mass is thought to be protective against osteoporosis and fractures later in life.[92] However, many children do not consume adequate calcium.[72] The DRIs for calcium intake are 700 mg per day for children ages 1–3 years and 1,000 mg per day for children ages 4–8 years.[41] An important aspect of adequate calcium intake in toddlers and preschoolers is the development of eating patterns that will lead to adequate calcium intake later in childhood.[92]

Dairy products are good sources of calcium, as are canned fish with soft bones such as sardines, dark-green leafy vegetables such as kale and bok choy, tofu made with calcium, and calcium-fortified foods and beverages such as calcium-fortified orange juice (Table 1.14). Nonfat and low-fat dairy products are low in saturated fat while still serving as a good source of calcium.

Fluids Healthy toddlers and preschoolers will consume enough fluids through beverages, foods, and sips and glasses of water to meet their needs. Fluid requirements increase with fever; vomiting; diarrhea; and when children are in hot, dry, or humid environments.

Consumption of milk has decreased among young children since the late 1970s, but consumption of carbonated soft drinks has increased by about the same amount. According to food consumption surveys, young children aged 4 to 7 years consume large amounts of sweetened beverages, including fruit juice, soft drinks, and sweetened iced tea, to the detriment of the overall nutritional balance of their diet and oral health. Consumption of sugar-sweetened beverages and 100 percent fruit juice begins at a young age and has increased in recent years.[93,94] Approximately 46 to 50 percent of children ages 2–5 years consume soft drinks.[95,96] Sugar-sweetened beverages contribute 7.3 percent of total calorie intake for children.[97] Children with high consumption of regular soft drinks (more than 9 oz per day) consume more calories and less milk and fruit juice than those with lower consumptions of regular soft drinks. Water is a good and underused "thirst quencher" for toddlers and preschoolers, as long as milk (2 cups) is part of their regular diet and fruit juice consumption is 4 ounces or less for children 1–3 years and 4 to 6 ounces for children 4–6 years old, as recommended by the AAP.[98,99] Parents and caretakers can offer children water to drink between meals and snacks.

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Recommended Versus Actual Food Intake

Ongoing national surveys examine food and nutrient intakes of Americans, including young children. The report "What We Eat in America" (WWEIA), a joint project of the USDA and DHHS, is the dietary intake component of the NHANES. In these national surveys, dietary data for children younger than 6 years of age is provided by an adult caretaker.[100]

According to the most recent WWEIA report, which utilizes data from the NHANES 2017–2020 prepandemic and the USDA's Continuing Survey of Food Intakes by Individuals (CSFII),[101,102] young children meet their energy needs, and more than enough protein and fat (Table 10.11). Toddlers who participated in the Feeding Infants and Toddlers Study (FITS) 2016 met or exceeded estimated energy requirements.[101,103] The total fat intake of 34.4 percent of males and 34.1 percent of females of total calories is within the target range of 30 to 40 percent for children this age. Two- to 5-year-olds have a mean sodium intakes of 2,331 mg per day for boys and about 2,031 mg per day for girls, with the sodium intake recommendation at 2,300 mg per day.[72,101,102]

In a longitudinal study of the nutrient and food intakes of preschool children ages 24–60 months, mean intakes of zinc, folic acid, and vitamins D and E were consistently below the recommended levels.[101] Low intakes of zinc, vitamin E, and iron were found in toddlers ages 12–18 months, a time of dietary transition.[101,102,104] Vitamin E intakes less than the estimated average requirement were found in toddlers and preschoolers who participated in the FITS 2016.[101,103] The means for nutrient intakes often hide problems at the extremes, however. They fail to indicate the percentage of children with low nutrient intakes of less than 66 percent of the recommended levels, and children with high nutrient intakes that exceed the Tolerable Upper Intake Levels.

The diets of children who ate fast food were found to be higher in total energy, total fat, total carbohydrate, added sugars, and sugar-sweetened beverages, and to have less fiber, less milk, and fewer fruits and nonstarchy vegetables than the diets of children who did not eat fast food.[105] Using this same data set, it was found that 11 percent of children ages 2–3 years and 12 percent of children ages 4–5 years consumed greater than 25 percent of total energy from added sugar. Increased added sugar consumption was associated with decreased nutrient and food-group intakes and increased percentage of children not meeting the DRIs.[106] Children's portion sizes have remained constant over the years, except for meat portions, which have decreased. This stability in portion sizes of young children over time reinforces the hypothesis that young children are capable of self-regulating energy intake. Portion sizes were positively related to both body weight percentiles and energy intake. It seems that young children self-regulate energy intake by adjusting portion size.[107]

Cross-Cultural Considerations

When working with families from different cultures, it is important to learn as much as possible about the culture's food-related beliefs and practices. Ask the parents and caretakers about their experiences with food, including foods used for special occasions. It is also helpful to know whether foods are used for home remedies or to promote certain aspects of health. Cultural beliefs influence many child feeding practices, such as what foods are best for young children, which cause digestive upsets, or which help relieve illnesses. It is important for the health-care provider to build on the cultural practices of the family and to reinforce the positive practices while attempting to affect change that could be more beneficial to the young child. For example, peanut or polyunsaturated oils can be recommended to Chinese Americans for stir-frying instead of the more traditional lard or chicken fat.

Vegetarian Diets

Young children can grow and develop normally on vegetarian or vegan diets, as long as their dietary patterns are intelligently planned. Vegetarian diets are rich in fruits, vegetables, and whole grains, the consumption of which is encouraged for the general population. However, young children in particular need some energy-dense foods to reduce the total amount of food required. The amount of vegetarian foods needed to meet nutrient needs may be more food than young children can eat. Young children need to eat several times a day to meet their energy needs because their stomachs cannot hold a lot of food at one time.

Table 10.11 Mean percentages of total calories from carbohydrate, protein, total fat, saturated fatty acids, and cholesterol intake[100,102]

2–5 Years of Age	Carbohydrate (%)	Protein (%)	Total Fat (%)	Saturated Fatty Acids (%)	Cholesterol (mg/day)
Males	56.0	14.0	31.0	11.0	170
Females	55.0	15.0	32.0	12.0	178

Source: Data from www.ars.usda.gov. Table created by Nancy H. Wooldridge.

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Children who are fed **vegan** and **macrobiotic diets** tend to have lower rates of growth, although still within normal ranges, during the first five years of life compared to children given a mixed diet.[108] Strict vegan diets, which exclude all foods of animal origin, may be deficient in vitamins B_{12} and D, zinc, and omega-3 fatty acids, and may also be low in calcium, unless fortified foods are consumed. Protein needs are usually met if the diet is adequate in energy and a variety of foods are included.[109] Children on vegan diets should receive vitamin B_{12} supplements or consume fortified breakfast cereals, textured soy protein, or soy milk fortified with vitamin B_{12}. The vitamin B_{12} status of children following vegetarian and vegan diets should be monitored on a regular basis, as vitamin B_{12}–deficiency may cause vitamin B_{12}–deficiency anemia, leading to fatigue, pale skin, and shortness of breath. Iron-deficiency anemia is an infrequent problem among children consuming a vegetarian diet.

Vitamin D adequacy can be achieved through diet or by sun exposure. Good sources of vitamin D for children include fortified soy milk, fortified breakfast cereals, and fortified margarines. Zinc is found in foods of animal origin. Plant sources of zinc include legumes, nuts, and whole grains. Vegetable products are also lacking in omega-3 fatty acids. Therefore, including a source of these fatty acids, such as canola or soybean oils, is advisable.[110] Foods containing phytates, such as unrefined cereals, may interfere with calcium absorption; if the child's diet contains a lot of unrefined cereals, higher calcium intakes may be needed.[110] Good sources of calcium for children on strict vegetarian diets include calcium-fortified soy milk, calcium-fortified orange juice and breads, tofu processed with calcium, blackstrap molasses, sesame seeds, tahini (sesame butter), almond and almond butter, and certain vegetables, such as broccoli and kale.[10] Calcium in vegetables such as spinach, Swiss chard, beet greens, and rhubarb is not well absorbed because insoluble calcium oxalate is formed with the high amounts of oxalate in these vegetables. Supplements may be necessary for some children with inadequate intakes that are not remedied by dietary means.

Guidelines for vegetarian eating practices for young children include:[12]

- Provide three meals and two to three snacks per day. Avoid serving bran and excessive intake of bulky foods, such as raw fruits and vegetables.
- Encourage eating nutrient-dense foods such as cheese, avocado, soy cheese, hummus, nut butters, tahini, and tofu.
- Provide an omega-3 fatty acid source, such as canola oil, soybean oil, tofu, soybeans, walnuts, and wheat germ.
- Avoid excessive restriction of dietary fat.
- Ensure an adequate intake of calcium, zinc, iron, and vitamins B_{12} and D.

vegan diet The most restrictive of vegetarian diets, allowing only plant foods.

macrobiotic diet This diet falls between semi-vegetarian and vegan diets and includes foods such as brown rice, other grains, vegetables, fish, dried beans, spices, and fruits.

Child Care Nutrition Standards

"... child-care programs should achieve recommended benchmarks for meeting children's nutrition needs in a safe, sanitary, and supportive environment that promotes optimal growth and development."[110]

—The Academy of Nutrition and Dietetics (formerly the American Dietetic Association)

An estimated 12.6 million children in the United States require child care while their parents work, making foods children eat away from home a major contribution to their overall intake. The number of children in child care decreased by 32 percent in December 2020 following the COVID-19 pandemic.[111] Nutrition standards for child care services exist and specify minimum requirements for amounts and types of foods to include in meals and snacks, as well as food-service safety procedures.[112] These standards also address nutrition learning experiences and education for children, staff, and parents as well as the physical and emotional environment in which meals and snacks are served. It is recommended that children in part-day programs (4–7 hours per day) receive food that provides at least one-third of their daily energy and nutrient needs in at least one meal and two snacks or two meals and one snack. A child in a full-day program (8 hours or more) should receive foods that meet one-half to two-thirds of the child's daily needs based on the DRIs in at least two meals and two snacks or three snacks and one meal. Food should be offered at intervals of not less than 2 hours and not more than 3 hours and should be consistent with the *Dietary Guidelines for Americans*.[72] Healthy People 2030 Nutrition and Weight Status objective NWS-1 is to increase the number of states with nutrition standards for foods and beverages provided to preschool children in childcare and Physical Activity objective PA-9 is to increase the number of states with licensing regulations for physical activity in child care.[7]

Physical Activity Recommendations

Physical activity is an important component of a healthy lifestyle. Physical activity helps maintain energy balance while strengthening muscles. Inactivity is thought to be a major contributor to the increasing prevalence of obesity. The *Dietary Guidelines for Americans 2020–2025* recommend that

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children engage in active play several times a day.[72] Some suggested activities for preschoolers from MyPlate[13] include:

Outdoor Activities:

- Games in the yard or park
- Family walks after dinner
- Walking the dog together
- Freestyle dance
- Playing catch
- Family bike rides on the weekend

Indoor Activities:

- Follow the leader
- Playing with a dog
- Hide and seek
- Ring-around-the-rosy
- Simon says
- Walking around the shopping mall or museum

This advice is reinforced by the AAP[113] The AAP suggests that toddlers, under the supervision of an adult caregiver, engage in activities such as walking in the neighborhood, park, or zoo and free play outdoors. For the preschool-age child, the AAP lists appropriate activities as running, swimming, tumbling, throwing, and catching, under adult supervision. No television viewing is recommended for children less than 2 years of age, while screen time should be limited to less than 2 hours per day for all other age groups. Removing screens from children's bedrooms is also recommended.[37] Parents are encouraged to set a good example for their children by being physically active themselves and limiting the amount of time that the family spends watching TV and playing computer and video games.

10.8 Nutrition Intervention for Risk Reduction

Nutrition Assessment

Components of a nutrition assessment include a food/nutrition-related history, pertinent biochemical measurements, anthropometric measurements such as weight, height, body mass index percentile, and a medical history (Table 10.12). Based on this information, the nutrition professional can identify any nutrition diagnoses, design a nutrition intervention plan with family input, and make a plan for monitoring and evaluation (Table 2.10 for the four steps of the Nutrition Care Process).

Bright Futures: Nutrition

Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents is a resource that provides health-care professionals with evidence-based recommendations for pediatric health promotion, health supervision, and anticipatory guidance. The mission of Bright Futures is to promote and improve the health, education, and well-being of infants, children, adolescents, families, and communities. It also supports the Healthy People objectives for the nation and can be used to develop and implement programs and policies for the health and well-being of infants, children, and adolescents.[114]

Many different user-friendly materials and tools are available from this program to assist in the implementation of the guidelines. In addition to the "Bright Futures Guidelines for Health Supervision," implementation guides have been published for oral health, general nutrition, physical activity, mental health, and families.

Bright Futures: Nutrition, 4th edition, focuses on health promotion and disease prevention for infants, children, adolescents, and families. It promotes positive attitudes toward nutrition and offers guidance on choosing healthful foods. Consistent with key Bright Futures principles, family meals are emphasized because they are associated with better diets; build on family strengths; and promote unity, social bonds, and good communication. Nutrition supervision guidelines are given for each age group, and within each broad age group, interview questions, screening, and assessment; tips for anticipatory guidance are also provided. The program information includes a section on frequently asked questions and resources for families for each broad age group. The implementation guide also addresses special issues and concerns related to pediatric nutrition, including oral health, vegetarian eating practices, iron-deficiency anemia, pediatric undernutrition, and obesity. The *Bright Futures: Nutrition* guidelines are a valuable resource for anyone who is interested in promoting healthy eating and

Table 10.12 Normal values of biochemical nutritional parameters[50,78]

Test Iron Status	Normal Values
Hematocrit, %	39
Hemoglobin, g/dL	14
Serum ferritin, ng/mL	>15
Serum iron, mcg/dL	>60
Serum total iron binding capacity, mcg/dL	350–400
Serum transferring [revert to original] saturation, %	>16
Serum transferrin, mg/dL	170–250
Erythrocyte protoporphyrin, mcg/dL red blood cells	>70
Lead screening	
Blood lead levels	<10 mcg/dL
Dyslipidemia screen	
Total cholesterol	<170 mg/dL
LDL cholesterol	<110 mg/dL

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physical activity behaviors in children. Ordering information for Bright Futures materials is available on the program's website (https://brightfutures.aap.org).

10.9 Public Food and Nutrition Programs

Young children and their families can benefit from a number of federally sponsored food and nutrition programs. Four example programs are presented here.

WIC (https://www.fns.usda.gov/wic/eligibility-and-coverage-rates)

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC),[115] previously described in Chapter 8, is administered by the Food and Nutrition Service of the USDA. It is one of the most successful federally funded nutrition programs in the United States. In an average month, an estimated 12.51 million people receive benefits from the Special Supplemental Nutrition Program For Women, Infants, and Children.[116] Participation in WIC services improves the growth, iron status, and quality of dietary intake of nutritionally at-risk infants and children up to age 5 years.[116,117]

To participate in the WIC program, infants and children up to age 5 years old must live in a low-income household, 185 percent or less of the federal poverty level, be enrolled in Supplemental Nutrition Assistance Program (SNAP) or Medicaid, and be at "nutrition risk." "Nutrition risk" means a child has a medical or dietary-based condition that places the child at increased risk. Such conditions include iron-deficiency anemia, underweight, overweight, or a chronic illness such as cystic fibrosis, or consumption of an inadequate diet.[116,117] Children receive nutrition assistance, education, and follow-up services by specially trained registered dietitians and nutritionists. Recipients of WIC benefits are provided with either vouchers, checks, or electronic benefits transfer (EBT) that allow them to obtain specific types of food from participating retail stores at no charge. Revisions in the WIC food packages to coincide with the *Dietary Guidelines for Americans* include low-fat or nonfat milk, whole-grain bread and cereals, and the substitution of soy milk and tofu for milk and cheese.[117]

WIC's Farmers' Market Nutrition Program

The Farmers' Market Nutrition Program (FMNP) is a special seasonal program for participants in WIC. This program provides vouchers for the purchase of locally grown produce at farmers' markets. The program is designed to help low-income families increase their consumption of fresh fruits and vegetables. Approximately 1.7 million WIC participants received FMNP benefits in 2017.[115,116]

Head Start and Early Head Start

Administered by the U.S. Department of Health and Human Services, Head Start and Early Head Start are comprehensive child development programs, serving children from birth to 5 years of age, pregnant women, and their families. Over 1 million U.S. children participate in this program. The overall goal is to increase the readiness for schoolchildren from economically disadvantaged families. A range of individualized, culturally appropriate services are provided through Head Start and related agencies, including educational, health, nutritional, social, and other services.[118] More specific information about Early Head Start can be found in Chapters 8 and 9.

Supplemental Nutrition Assistance Program

The Supplemental Nutrition Assistance Program (SNAP), administered by the USDA, is designed to help adults in low-income households buy food, thereby improving food security and nutrition of participants. In FY 2022, about 41.2 million individuals living in 5.4 million households received assistance in the United States.[119] The monetary amount of food vouchers provided to an eligible household depends on the number of people in it and the income of the household. Income eligibility criteria for this and a number of other federal programs can be found on the USDA's Food and Nutrition Service website (www.fns.usda.gov/snap/supplemental-nutrition-assistance-program-snap). The average monthly amount of benefits received through SNAP in 2022 was $223.33 per individual, enough to help families and individuals pay for a portion of the food they need. Each state must develop a nutrition education plan for SNAP recipients based on federal guidance.[120] Participation in SNAP is associated with increased intakes of a number of nutrients and a decrease in food insecurity by roughly 30 percent.[120,121]

Key Points

1. Periodic and accurate measurements of a young child's growth are important indicators of the child's nutritional status. Adequate and appropriate growth is the ultimate outcome indicator of adequate nutrition and health.
2. The types of foods offered to children and methods of feeding are based on an individual child's growth and development.
3. Food habits are learned behaviors.

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4. Common nutritional problems such as iron -deficiency anemia, dental caries, and constipation in a healthy child can be addressed through adjustments in the child's diet.
5. The risk for overweight and obesity is increasing even among young children in the United States.
6. The U.S. *Dietary Guidelines* recommend that children eat a variety of foods and increase physical activity.
7. MyPlate reinforces eating a variety of foods and increasing physical activity.
8. Surveys of food intake indicate that most children meet their nutritional needs, but that their intakes exceed recommendations for energy and saturated fat.
9. A well-planned vegetarian diet can meet the needs of a growing child.
10. Public food and nutrition programs are important resources for many young children in the United States.

Review Questions

1. Which of the following growth parameters is used as a screening tool for assessing underweight and overweight or obesity in young children?
   a. Weight-for-age percentile
   b. Length- or stature-for-age percentile
   c. Body mass index-for-age percentile
   d. Actual body mass index (weight in kg/height in m^2)
   e. Actual weight in kg
2. Which of the following strategies would be appropriate for parents to use in teaching their young child healthy eating behaviors?
   a. Give a dessert as a reward for eating fruits and vegetables.
   b. Expect the child to eat foods that parents will not eat themselves.
   c. Coax the child to eat, especially new foods.
   d. Serve child-sized portions or allow the child to self-serve portions.
   e. Make the child stay at the table until she has cleaned her plate.
3. Obesity is defined as:
   a. Weight-for-age percentile ≥ 85th to 94th
   b. Weight-for-age percentile ≥ 95th
   c. Weight-for-length percentile ≥ 95th
   d. BMI-for-age percentile ≥ 85th to 94th
   e. BMI-for-age percentile ≥ 95th
4. Which of the following statements regarding fat in children's diets is correct?
   a. Dietary fat is an important source of calories in a young child's diet.
   b. The amount of saturated fat is not restricted in a young child's diet.
   c. The amount of *trans* fatty acids is not restricted in a young child's diet.
   d. Restricting fat in a young child's diet has been shown to decrease growth.
   e. Dietary fat recommendations are the same for children regardless of cardiovascular disease risk.
5. True or false: According to food consumption surveys, young children exceed estimated needs for calories.
6. Which of the following would be the best choice for a between-meal snack for a preschooler? Choose the one best answer.
   a. 100 percent fruit juice
   b. Raisins
   c. Fortified gummy bears
   d. Peanut butter crackers
   e. Oatmeal cookies
7. Several health and professional organizations and agencies, such as the AAP, the AMA, and the USDA, have published similar recommendations for a healthy diet for young children. Briefly describe the food components of such a diet.
8. Describe the role of physical activity in a healthy lifestyle for young children. Give examples of appropriate activities for children.

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CDC/PHIL

Toddler and Preschooler Nutrition

Conditions and Interventions

Prepared by Judith E. Brown with Ellen Lechtenberg

Learning Objectives

After studying the materials in this chapter, you should be able to:

11.1 Differentiate the similarities and differences in young children with and without special health-care needs.

11.2 Identify the more common nutrition problems in young children with special health-care needs that result from chronic health conditions.

11.3 Recognize approaches for completing a growth assessment in young children with special health-care needs.

11.4 Describe how feeding difficulties in preschoolers and toddlers are included in nutrition assessments and interventions.

11.5 Identify conditions in young children with special needs in which nutrition services are a part of medical management.

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11.6 Review food allergy and intolerance consequences for young children.

11.7 Describe the concerns with the use of dietary and herbal remedies in young children with special health-care needs.

11.8 Explain how families access community and regional resources that provide nutrition services for toddlers and preschoolers with chronic health problems.

11.9 Review some of the nutritional concerns due to the COVID-19 pandemic.

Introduction

Most toddlers and preschoolers are healthy and develop as expected. Most are not referred to nutrition services unless their low-income families participate in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program. This chapter discusses children who do not fit the typical pattern, **children with special health-care needs** associated with a **chronic condition** or disability, or children who are at risk. Nutritionists with pediatric experience spend most of their time with these children and their families. This chapter covers nutrition needs and services for young children with autism spectrum disorder (ASD), food allergies, breathing or **pulmonary** problems, feeding and growth problems, developmental delays, and those at risk for needing nutritional intervention.

This chapter demonstrates how nutrition assessments, diagnoses, and interventions complement medical diagnoses and medical treatment. Healthy People 2030 objectives (Table 10.1) include children with special health-care needs, especially in those objectives concerning access to health-care and reducing health-care disparities.[1] Some objectives are not appropriate because children with specific conditions may have different energy needs or key nutrient requirements than their healthy peers. Similarly, the *2020–2025 Dietary Guidelines* are based on a healthy population are not adapted for children with special health-care needs.[2]

11.1 Who Are Children with Special Health-Care Needs?

The child who does not meet the appropriate developmental milestones may be recognized as having a chronic condition. It can be difficult and expensive, however, to identify other children with special health-care needs. Nutrition services are needed regardless, although the type of nutrition assessment and interventions differ.

The earlier special educational, nutritional, and health-care interventions are started, the better for the overall child's development. Criteria used for identifying disabilities in adults do not fit children, as these criteria are related to a person's ability to work or perform household chores.[3] *Chronic condition* and *disability* mean the same thing in referring to toddlers and preschoolers. Prevalence estimates for disabilities range from 5 percent to 31 percent of children.[4,5]

The Health Resources and Services Administration (HRSA) Maternal and Child Bureau reported approximately 19.4 percent of children in the United States have a special health need representing approximately 14.1 million children. The 2019–2020 National Survey of Health reported a higher incidence of children with special health needs for children living in poverty (22.8 percent) and for non-Hispanic Black children (23.3 precent)[6] The 2016, 2017, 2018, and 2019 surveys reported 17.8 percent of children ages 0–5 years have special health-care needs.[7] Nutritional problems are common in children with disabilities and up to 90 percent of children with disabilities have some type of nutrition problem.[8]

Nutrition services are provided to toddlers and preschoolers who carry forward medical and nutrition diagnoses from infancy. The majority of infants are healthy, so this group of infants who become children with special health-care needs is only a small percentage of the population. What is rapidly growing is that portion of healthy-appearing toddlers and preschoolers who are at risk for health or developmental problems especially now due to the COVID-19 pandemic and its variances affecting the nutritional needs of children. The availability of services for toddlers and preschoolers who are at risk for nutritional or developmental delays has been positively impacted by parent advocacy groups and professional organizations that have identified the value of early intervention services.

children with special health-care needs A general term for infants and children with, or at risk for, physical or developmental disabilities or chronic medical conditions from genetic or metabolic disorders, birth defects, premature births, trauma, infection, or prenatal exposure to drugs.

chronic condition Disorder of health or development that is the usual state for an individual and unlikely to change, although secondary conditions may result over time.

pulmonary Related to the lungs and their movement of air for exchange of carbon dioxide and oxygen.

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Table 11.1 Educational, medical, and nutrition problems for one toddler and one preschooler

"Bill," an 18-month-old boy (born at 30 weeks of gestation)		
Education Problems	**Medical Problems**	**Nutrition Problems**
Twenty-five percent delay in motor, social, and cognitive skills documented, meeting eligibility for services under The Infants and Toddlers with Disabilities Program (Part C) of the Individuals with Disabilities Education Act (IDEA)	Diagnosed, treated seizures, short stature	Self-restricted energy and nutrient intake due to prolonged use of infant formula fed in a bottle, with acceptance of only pureed foods from a spoon
"Sue," a 4-year-old with autism spectrum disorder		
Education Problems	**Medical Problems**	**Nutrition Problems**
Speech and language impairment, banging and hitting behaviors (emotional disturbance), meeting eligibility for the Individuals with Disabilities Education Act (IDEA)	Sleep disruption, complaints about gastrointestinal pain two times/week, in diagnostic testing	Dietary analysis of food and nutrient intake shows food refusals resulting in excessive liquids and sugar intake; inadequate calcium, vitamin D, and iron; lack of a consistent meal and snack pattern

Although the importance of identifying problems early to start therapy has been recognized for a long time, the American Academy of Pediatrics (AAP) and developmental pediatricians have intensified efforts to screen all toddlers in primary care offices.[9,10] Nutrition-related problems also can be identified in primary care offices when developmental screening is conducted. The process of finger and then spoon feeding is a developmental milestone for toddlers; and so many health-care providers, such as speech-language therapists and occupational therapists, work with families when children have feeding concerns. Nutritionists work as part of a multidisciplinary team with such providers.

Toddlers and children are entitled to the same services as older people with chronic illnesses. They are covered by the Americans with Disabilities Act (ADA), the Social Security Disability Insurance (SSDI) program, the Supplemental Security Income (SSI) program, and services available for families with limited health-care resources.[3,11] Educational regulations ensure that all children with disabilities have a free, appropriate public education. Nutrition services are funded within education regulations in the Individuals with Disabilities Education Act (IDEA).[11]

Parents of a healthy child may choose and pay for day care or a preschool program. For a child with special health-care needs, day care or educational programs are selected based on nutrition and other types of therapy provided by state and federal resources. Nutrition services can be provided to young children within special educational programs and services both as preschoolers (3–5 years old) and toddlers up to 3 years old.[4,5] Services have to be culturally appropriate for various ethnic groups, reflecting food preferences, religious beliefs, and sensitivity to dress and language; otherwise, they are likely to be rejected.

There are a variety of services for chronically ill and at-risk toddlers and preschoolers, both medical and educational, that vary with regulations from state to state. Educational services categorize health problems differently than by medical diagnoses. This chapter and Chapter 13 present both educational and medical systems to identify how nutrition services fit in (Table 11.1).

One of the best resources for providers and families to find services is the National Dissemination Center for Children with Disabilities, funded by the U.S. Department of Education and the Center for Parent and Information Resources.[11] These sites identify disabilities for toddlers and preschoolers and have outcome studies on the effectiveness of educational interventions. Families are encouraged to seek out information and resources to navigate the complexity of educational, medical, and nutrition resources for their young with special health-care needs.

Many nutritionists work in community-based **early intervention services** funded by the Infants and Toddlers with Disabilities Program (Part C) of the Individuals with Disabilities Education Act (IDEA) (Table 11.2). A child's eligibility for services does not require a specific diagnosis. Infants and toddlers under the age of 3 are eligible for early intervention services if they are experiencing developmental delays, as measured by appropriate diagnostic instruments and procedures, in one or more of the following areas:[12]

- Cognitive development
- Physical development
- Communication development
- Social or emotional development
- Adaptive development; or have a diagnosed physical or mental condition that has a high probability of resulting in developmental delay

early intervention services Federally mandated evaluation and therapy services for children in the age range from birth to 3 years under the Individuals with Disabilities Education Act.

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Table 11.2 Early intervention nutrition services for children up to 36 months old

Requirements	Align with Part C educational program state requirements Align with the child's "Family Individualized Education Plan," which addresses: • Where services are provided: the child's home, school, day care • Who are team members, such as speech-language pathologist, case workers, medical providers, in addition to registered dietitian nutritionists Document in local medical, educational, or other tracking systems to comply with funding sources
Service examples	Assess daily food and nutrient intake using a dietary analysis program Assess safety of dietary supplements, over-the-counter (OTC) products, and prescribed formulas Evaluate nutrition care plan implementation at day care Coordinate with the speech-language pathologist the plan for stimulating self-feeding Track and interpret growth pattern Observe developmental therapies in planning nutrition care Communicate with specialty care providers about a specific nutrition problem
Supporting families	Respond to parent and grandparent questions about food choices Attend care conference to plan a school transition Arrange for menu adjustments at day care–provided meals Educate caregivers in advocating for the child's access to a special formula Educate about safe allergy-related food restrictions
Advocacy activities	Offer a continuing education session for colleagues about special formulas Present nutrition recommendations to a parent advocacy group Contribute nutrition educational resources for a school-based health fair

The term may also include, if a state chooses, children under 3 years of age who would be at risk of experiencing a substantial developmental delay if early intervention services were not provided.

A number of chronic conditions are suspected, but not obvious, in the first year of life. The diagnosis often becomes clear in the toddler and preschool years. Standardized developmental screening, evaluation, and testing for these ages show more reliability than they do for infants.

11.2 Nutrition Needs of Toddlers and Preschoolers with Chronic Conditions

Toddlers or preschoolers with chronic health conditions are at risk for the same nutrition-related problems and concerns as are other children.[10] Consequently, every attempt should be made to meet their overall nutritional needs and to ensure normal growth and development. The DRIs for toddlers and preschoolers provide a good starting point for setting protein, vitamin, and mineral needs for children with chronic conditions.[13,14] The recommendations for typical children concerning dietary fiber, prevention of lead poisoning, and iron-deficiency anemia usually apply to children at risk or already diagnosed with special health-care needs.[15]

Standard nutrition guidance does not apply for children with some specific conditions. For example, children with sickle-cell disease have specific blood iron testing with interpretation that differs from the standard guidelines. Iron-rich foods to increase their iron stores may not be required if the child is also receiving iron through blood transfusions. Nutrition assessments, diagnoses, and interventions must be customized to the child.[16]

Chronic conditions may result in poor appetite, although nutrition assessment may document increased energy needs (Table 11.3).[17] A child may have an interval of needing additional energy based on the course of the chronic condition. Changes in energy needs may explain why both underweight or overweight are more common in children with chronic conditions than in other children.[17] Overweight and obesity are commonly found with Down syndrome and spina bifida.[18,19] Nutrition assessment and diagnoses would include excessive energy intake as a consequence of low muscle mass, lower mobility, and short stature. Excess body weight can exacerbate other health conditions and should be avoided.

Underweight results in part from the chronic illness and its medical treatment. Nutrition assessments for children with chronic illnesses often document weight loss with any flare-up or exacerbation of the primary condition. Nutrition interventions for underweight children with a chronic

Table 11.3 Chronic conditions generally associated with high- and low-energy needs

Higher Energy Needs	Lower Energy Needs
Cystic fibrosis	Down syndrome
Renal disease	Spina bifida
Ambulatory children with diplegia	Nonambulatory children with diplegia
Pediatric AIDS	Prader–Willi syndrome
Bronchopulmonary dysplasia (BPD)	Nonambulatory children with short stature

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condition may or may not recommend food choices for weight gain. Avoidant/Restrictive Food Intake Disorder, or ARFID, is a diagnosed eating disorder in children that replaces the diagnosis of "feeding disorder of infancy or early childhood" that was limited to children 6 years old and younger. ARFID does not have an age restriction. Children with ARFID do not have body image concerns like children with anorexia nervosa or bulimia nervosa.[20] Someone with ARFID does not eat enough calories for their body to work properly. In children, it can lead to delayed weight gain and growth.[21]

Nutrition interventions regarding food intake, vitamin and mineral supplementation, and mealtime behaviors also should be customized to the individual child. Children who are frequently sick or have low energy levels and appetites may avoid foods that require chewing or take a long time to eat. Dietary preferences related to chronic illness may result from the child's behavior. It is age-appropriate for children to express their food likes and dislikes, insist on their independence, and go on food jags. It is important to distinguish between decreased appetite related to food-intake problems because of the chronic illness and those related to normal developmental stages in the toddler and preschool years.

11.3 Growth Assessment

Most toddlers and preschoolers with chronic conditions are provided with an assessment of nutritional status as a first step in determining whether more intensive levels of nutrition services are needed. The need for nutrition services is identified by answers to these questions:

- Is the child's weight, height, and other indices reaching appropriate percentiles on growth charts?
- Is his or her food and nutrient intake adequate?
- Are the child's feeding or eating skills appropriate for the child's age?
- Does the medical or nutrition diagnosis affect nutritional needs?

Rett syndrome Condition in which a genetic change on the X chromosome results in severe neurological delays, causing children to be short, thin-appearing, and unable to talk.

meningitis Viral or bacterial infection in the central nervous system, which causes inflammation of the membranes covering the brain and spinal cord that is likely to cause a range of long-term consequences in infancy, such as intellectual disability, blindness, and hearing loss.

intellectual disability Substantially below-average intelligence and problems in adapting to the environment and the person ability to learn at an expected level and function in daily life which emerge before age 18 years.

A variety of nutrition screening tools exist for assessing the nutritional status of young children. Screening consists of the collection of preliminary data in one or more of the following categories: Anthopometric parameters, clinical (medical history and diagnosis), biochemical laboratory data, diet, developmental feeding skills, behavior (related to feeding), socioeconomic characteristics.[22,23] Such tools are useful for children at risk as well as those with conditions such as asthma, HIV infection, allergies, and cerebral palsy. Screening tools identify those children who need in-depth nutrition services.[10] After assessment, nutrition intervention services provide methods to improve nutritional status. Several conditions that require nutrition intervention services include failure to thrive (undernutrition), celiac disease, breathing problems, and muscle coordination problems.

Children with special health-care needs often have conditions that affect growth even when adequate nutrients are provided. The World Health Organization (WHO) growth charts for children up to 24 months and the Centers for Disease Control and Prevention (CDC) growth charts for those older than 24 months should be utilized for assessing growth.[24,25] Specific growth charts developed for chronic conditions, when available, are recommended to be used.[22] Often both the CDC chart and the specialty chart give the best perspective of a growth pattern. For children up to age 3, who are born low birthweight (LBW) or very low birthweight (VLBW), various follow-up programs have clinical guidelines to adjust for preterm birth in interpreting growth over time. Corrections for prematurity, as discussed in Chapter 9, and for catch-up growth are examples of such clinical guidelines.

Pediatric health-care providers commonly evaluate head circumference on growth charts. Head circumference percentiles are used to determine whether head growth falls within normal limits or may indicate a neurological condition, such as **Rett syndrome**.[26,27] Rett syndrome is a rare disorder that almost exclusively occurs in girls, characterized by a reduced rate of head growth beginning in the toddler years (Figure 11.1).[27,28] Later, over time, the rate of weight and height gain slows in girls with Rett syndrome.[27,28] Decreased rate of head growth in toddlers and preschoolers may be indicative of problems from infancy, such as prematurity, or consequences of infection such as **meningitis**. The American College of Neurology recommends that children with microcephaly (head circumference at or less than the 3rd percentile for age) be screened for neurologic and cognitive problems as they are at risk for these conditions.[29] **Intellectual disabilities** may occur due to decreased head growth.

11.4 Feeding Problems

Feeding disorders are part of the continuum of health-related problems that require nutrition services. Children with special health-care needs have many of the same

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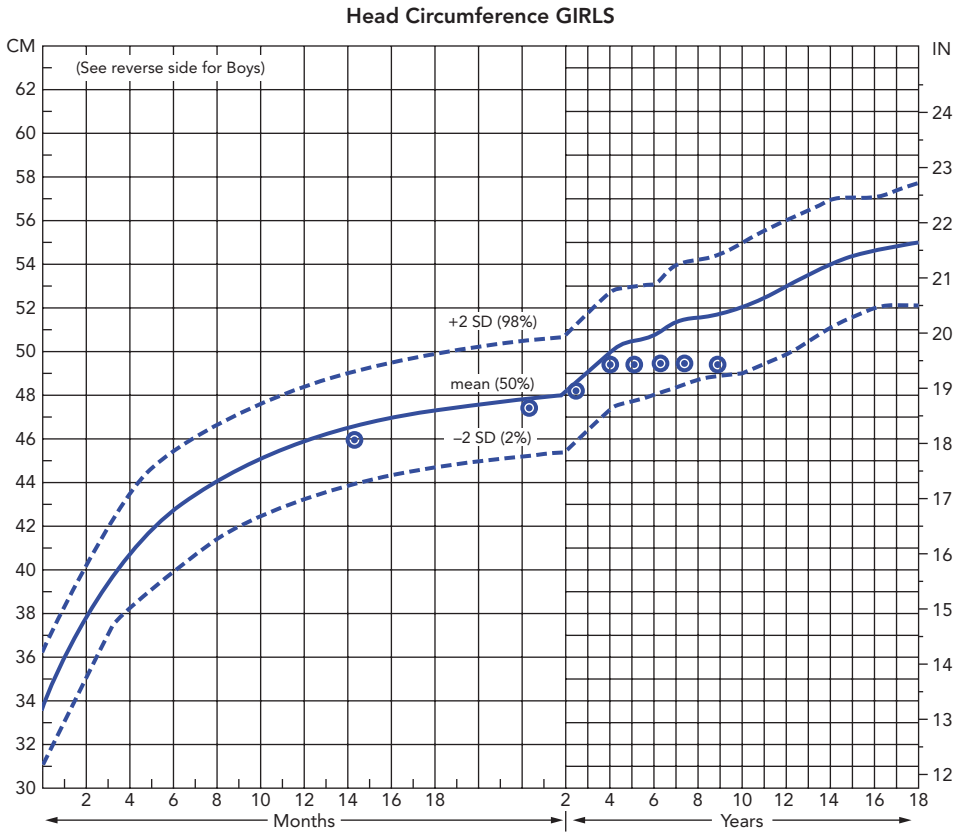


Figure 11.1 Nellhaus head circumference growth chart plotted for girl with Rett syndrome.

developmental feeding issues as other children, such as using food to control their parents' behavior at mealtime and going on food jags. In hindsight, some feeding problems are signs of underlying health conditions that emerge in the toddler and preschool years on top of the usual feeding challenges. Children with complex health-care needs may have major feeding disorders that may require them to be dependent on tube feedings and other such technologically advanced equipment.[30] Medical diagnoses that may present with signs of feeding problems include gastroesophageal reflux, developmental delay, cerebral palsy, and autism spectrum disorder.[8,15] Nutrition assessments for toddlers with these conditions document signs of feeding disorders, such as low interest in eating, long mealtimes (over 30 minutes), preferring liquids over solids, and food refusals. Children with or at risk for developmental delay often prove more difficult to feed as toddlers and preschoolers.[3] These children may consume excessive drink liquids or prefer foods usually eaten by younger children (refer to Case Study 11.1). Nutrition interventions for feeding disorders may include that the child requires foods and liquids that are appropriate for a younger child (Photo 11.1). Offering food textures that he or she can eat successfully, even if a monotonous daily intake results, or continuing to offer liquids in a bottle may be appropriate choices in these circumstances. Collaboration with a speech language specialist or occupational therapist who works with children with special health-care needs will assist the child in improving their feeding skills.

Table 11.4 shows an example of the likes and dislikes of a 2.5-year-old child. The child likes only a few foods, which are not especially nutritious. Usual recommendations are to add variety to the child's daily intake and to offer meats, milk, and vegetables. This recommendation is appropriate for a typical child, but this child's eating pattern suggests a feeding issue. The soft textures and mild tastes of preferred foods characterize a child closer to 1 year of age. The foods the child dislikes require more advanced oral motor skills. An evaluation of the child's overall level of functioning will likely indicate a developmental delay of the child's feeding skills.

Behavioral Feeding Problems

"Every mouth prefers its own soup."

—Sephardic saying

Mealtime behavioral problems and food refusals are common in children with behavioral and attention disorders. These concerns often bring parents to nutrition experts for solutions. Behavioral disorders that affect nutritional status include autism spectrum disorder (ASD)

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Case Study 11.1 A Picky Eater

Logan is a clean-cut boy almost 3 years old. He has been growing as expected, but he does not talk. He can walk and move about well, but he prefers to play alone. Favorite foods and drinks are juices in his sippy cup, which he likes to carry around; macaroni and cheese; white bread without crusts; mashed potatoes; Honeycomb cereal; and crackers. Logan cries and throws food that he does not like, such as hamburgers, fruits, most vegetables, and any food combinations. He will periodically eat cheese pizza, scrambled eggs, and applesauce.

His mother tries talking to the pediatrician about his picky appetite, but the pediatrician reassures her that Logan will eat when he is hungry and she should not worry. Logan's mother is frustrated that he is so difficult to take out to eat because of the tantrums he throws in restaurants and friends' homes. He sometimes eats a large portion of a food he likes. Most of the time, he is satisfied just drinking juices all day from his sippy cup, and he is rarely interested in eating when others eat. He is able to eat with a spoon, but he does not like to touch foods with his hands. Logan has been referred for speech therapy, but his therapy does not address his eating. His medical history shows that he was born full-term and has had three ear infections but no major illnesses.

Nutrition assessment shows that Logan is consuming adequate energy at 1,350 calories per day, or 85 cal per kg. His diet is excessive in vitamin C and B vitamins, with adequate protein at the RDA for his age. His sources of protein are mainly his starchy foods of bread, crackers, and dry cereal.

Nutrition assessment sources are the parent interview and physician records for Logan. Logan does not yet have a nutrition or medical diagnosis.

Questions

1. What are the signs that Logan's feeding problem may be related to his speech?
2. Because Logan is growing well and meeting his energy needs, why not just wait for him to mature to accept other foods?
3. Why would there be concerns with the pediatrician's statement that Logan will eat when he is hungry?



Photodisc

and attention-focusing problems, such as **attention deficit hyperactivity disorder (ADHD)**. ADHD may be suspected during the preschool years, but it is primarily diagnosed during school years (Chapter 13).

Children with ASD may display feeding problems resulting in a self-restricted food selection[17] (Table 11.5). A 2-year-old child with ASD may refuse to eat many foods and be rigid in what he will eat. He may not respond to feelings of hunger. When he is not given foods he likes, he may refuse to eat and have temper tantrums which could cause self-injury. This self-restricted dietary intake is part of the sensory and environmental factors found in those with ASD. Therefore, he prefers to drink rather than eat foods, so a high proportion of his total energy comes from one type of drink. Interventions to improve the food and nutrient adequacy for this child may include a complete vitamin and mineral supplement, and adding one new food by offering it many times (15–20 times) over 1 or 2 months. Nutrition interventions should be incorporated into this child's overall treatment plan, provided within a special education program (Case Study 11.1).

attention deficit hyperactivity disorder (ADHD)
Condition characterized by low impulse control and short attention span, with and without a high level of overall activity.

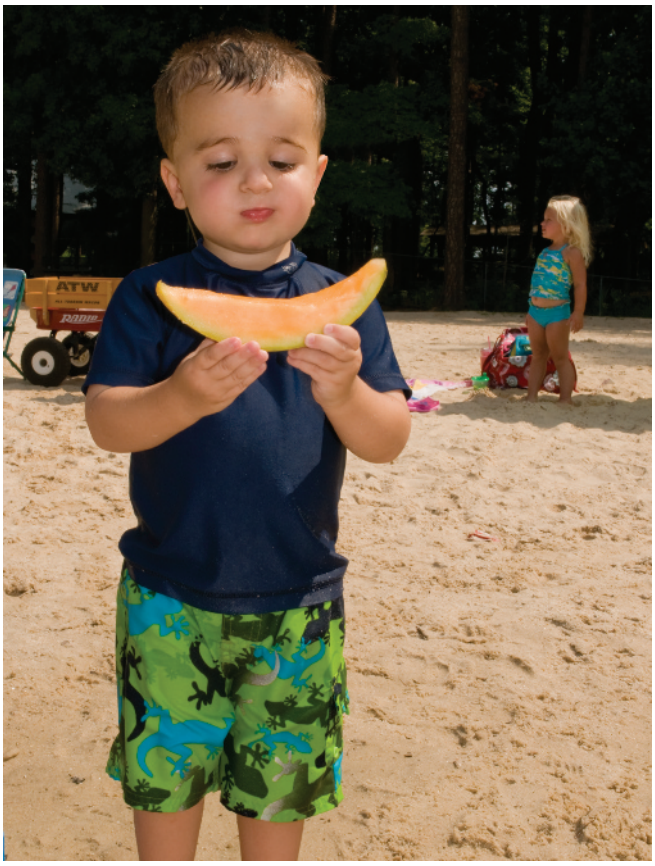
Excessive Fluid Intake

The food intake noted in Table 11.5 highlights a common issue related to excessive fluids. Many young children prefer to drink rather than eat solid foods, and this is more common in children with special health-care needs. The AAP recommendation to limit juice intake to 4–6 fluid ounces per day for ages 1–6 years applies to all children.[31,32] Calcium-fortified juices may be appropriate if other sources of calcium are limited, but these juices can also be overconsumed. In a child who already has gastrointestinal problems, it may not be clear if problems are caused by excessive juice intake.[31,32] In young children who may be less active due to chronic conditions, energy in excessive liquids is also a negative impact. Intake of high-sucrose beverages for young children raises concerns related to nutrient adequacy, as other more nutritious beverages are replaced.[33]

Feeding Challenges and Food Safety

Toddlers and preschoolers with chronic conditions are at greater risk for food-contamination problems. Fork-mashing or blending foods may invite bacterial

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CDC/PHIL

Photo 11.1 Toddlers with special health-care needs may need foods that require fewer oral skills to consume.

Table 11.4 Food choices of a 2.5-year-old child with suspected developmental delay

Likes	Dislikes
Three packets instant Cream of Wheat with added sugar and margarine (refused offered apple slices)	Hamburger meats or any other kind of meat
Macaroni and cheese (refused offered sandwich with lettuce and bologna)	Green beans or any kind of vegetables
Banana, with peel removed (refused other cut-up fruits offered)	Vegetable soup; salads of all kinds
Pudding, only chocolate Cheese puffs (refused corn chips)	Casseroles or any mixtures of foods
Juices of all kinds, in a sippy cup	Milk, and milk with any flavoring added

contamination or spoilage over time.[15] Liquid complete nutritional supplements and toddler formulas are subject to contamination once opened. Families with children dependent on feeding equipment and technology are aware of the high cost of such devices, and may use disposable items longer than recommended. Feeding tubes and supplies to deliver formula contribute to food-safety issues when they are not properly cleaned or replaced.

Table 11.5 Food and nutrient intake of 2-year-old child with a suspected autism spectrum disorder

Dry Fruit Loops cereal
10 fl oz calcium-supplemented orange juice drink
Chicken fingers from a specific fast-food restaurant
French fries
10 fl oz calcium-supplemented orange juice drink
Waverly crackers
Pringles potato chips
10 fl oz calcium-supplemented orange juice drink
Oatmeal cake
10 fl oz calcium-supplemented orange juice drink

Feeding Challenges from Disabilities Involving Neuromuscular Control

Children who have feeding challenges related to muscle control of swallowing or control of the mouth or upper body may choke or cough while eating or refuse foods that require chewing.[17] These types of feeding challenges result from conditions such as cerebral palsy or other **neuromuscular disorders** and genetic disorders such as Down syndrome. Feeding and swallowing difficulties in toddlers or preschoolers generally appear more severe than the reactions of infants who are learning how to munch and chew foods.[15,17] The decrease in appetite expected in toddlers and preschoolers may be pronounced in children who find eating difficult and unpleasant. These feeding challenges may require further study to make sure eating is safe for a child, and not related to frequent illness such as bronchitis or pneumonia.

A child with **hypotonia** or **hypertonia** in the upper body may experience difficulty sitting upright for a meal and self-feeding with a spoon.[10] If these feeding problems are not resolved by providing therapy in early-intervention programs or schools, children are likely to resist eating over time. Children who are not able to consume all their nutritional needs by mouth may require either a nasogastric or gastrotomy feeding tube. Feeding tubes are also utilized when an infant or child is at risk for choking or aspirating food or fluids from their oral cavity into their trachea and lungs.[17]

neuromuscular disorders Conditions of the nervous system characterized by difficulty with voluntary or involuntary control of muscle movement.

hypotonia Condition characterized by low muscle tone, floppiness, or muscle weakness.

hypertonia Condition characterized by high muscle tone, stiffness, or spasticity.

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Two concepts support services for families who have young children with complex health-care needs:

1. *Every family deserves a plan for coordinated, interdisciplinary care that* considers the child as a whole. This is more likely to be accomplished with a medical home. A **medical home** is an approach to providing comprehensive primary care that facilitates partnerships between patients, clinicians, medical staff, and families. A medical home extends beyond the four walls of a clinical practice. It includes specialty care, educational services, family support, and more.[34]
2. *Young children thrive best when they live at home, even those who are technology dependent and have complex health-care needs*. They benefit when ongoing care is provided in the family home rather than in a hospital, or in a series of rehospitalizations.[34]

These concepts also apply to nutrition services. For example, a 20-month-old girl Isabella has survived lengthy hospitalizations after birth and 8 months of age. She requires 12 daily medications, a mostly liquid diet modified in energy, both oral and non-oral feedings, physical therapy, speech and language therapy, and occupational therapy. Both of her parents work full time outside the home and so Isabella was enrolled in a nearby day care center where her therapists can provide their services. Isabella attends this day care center located in a school that participates in the USDA Child Nutrition Program. USDA regulations require a physician to sign an order for modifying the menu at school and child care sites. This paperwork cannot be signed by a nutrition expert who teaches the family how to implement the modified food and beverage choices at home. Additional paperwork is required for Isabella's expensive special formula for insurance coverage and for prescribed nutritional supplements. Isabella cannot chew well, so supplemental calcium and vitamin D are prescribed in liquid form. Her mother is able to keep her job in part because the pediatrician coordinates all the required reports, prescriptions, and paperwork. Isabella progresses in her oral feeding skills now that her therapies are coordinated.

medical home The medical home is best described as a model or philosophy of primary care that is patient-centered, comprehensive, team-based, coordinated, accessible, and focused on quality and safety.

medical neglect Failure of parent or caretaker to seek, obtain, and follow through with a complete diagnostic study or medical, dental, or mental health treatment for a health problem, symptom, or condition that, if untreated, could become severe enough to present a danger to the child.

Prader–Willi syndrome Condition in which partial deletion of chromosome 15 interferes with control of appetite, muscle development, and cognition. Most cases of Prader-Willi syndrome occur when a segment of the paternal chromosome 15 is deleted in each cell.

11.5 Nutrition-Related Conditions

Failure to Thrive

Failure to thrive (FTT) is defined as a weight for age that falls below the 5th percentile on multiple occasions or weight deceleration that crosses two major percentile lines on a growth chart.[15,35] FTT has a slightly different basis in toddlers and preschoolers, who may have grown adequately during the first year. Their decrease in growth rate occurs at the age when appetite typically decreases and control issues at mealtime are expected, making identifying the cause of FTT more difficult.[36] FTT may result from a complex interplay of medical and environmental factors, such as the following:[15,35,36]

- Digestive problems such as gastrointestinal reflux or celiac disease
- Asthma or breathing problems
- Neurological conditions such as seizures
- Pediatric AIDS

Children who have chronic illnesses or were born preterm have a higher risk of FTT as a result of abuse or **medical neglect**.[37] These children with special needs may be more irritable and demanding, which places them at risk for abuse or neglect. Often a specific nutrient or group of nutrients is suspected of being inadequate in children with FTT, when the more appropriate emphasis should be placed on energy and protein. As an example, copper and zinc in the blood of toddlers with FTT were reported to be the same as age-matched controls, although protein intake was lower.[38]

Recovery from FTT can include catch-up growth, which is acceleration in growth rate for age.[15] If energy is provided at a higher level than for a typical child of the same age, catch-up growth is likely (Figure 11.2). The length of time needed for catch-up growth varies, but some weight gain should be documented within a few weeks. For example, recovery from FTT for one 3-year-old was a gain of 6 lbs—more weight than is typical to gain in 1 year—within the first 3 months of living in a new home.

The opposite of FTT, obesity, is usually not a concern in the toddler and preschool age range when there is a medical history of a preterm birth. Increasingly, questions are being raised as to whether medical management of sick newborns does or does not increase the risk of diabetes and overweight later in childhood.[39] There is a growing group of overgrowth or obesity syndromes identified in the toddler and preschool age range that are quite different from typical childhood obesity. **Prader–Willi syndrome** is an example because the onset of obesity is typically after

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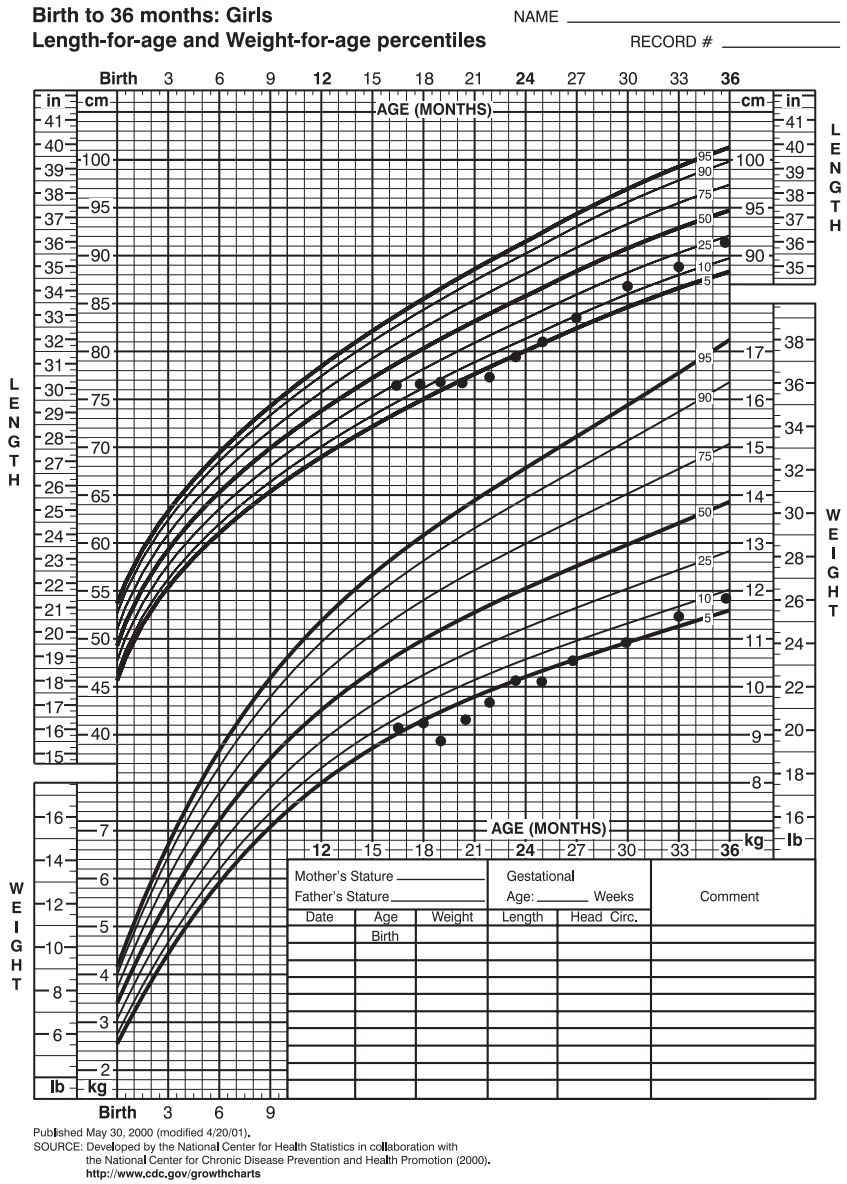


Figure 11.2 Growth chart for a girl with failure to thrive before and after intervention.

infancy.[17] Another example is Wiedemann–Beckwith syndrome, in which a rapid rate of weight gain is typical in toddlers.[17] Such conditions are not necessarily a result of excessive energy intake but rather from endocrine or metabolic abnormalities, body composition changes, or drug side effects. Many conditions have behavioral or developmental components that are found at older ages after the symptom of early obesity. Such conditions are good reminders of how nutrition services and recommendations have to be adjusted for children with special needs.

Toddler Diarrhea and Celiac Disease

Toddlers are likely to develop diarrhea. The condition is called toddler diarrhea, in which otherwise healthy, growing children have diarrhea so often that their parents bring them for a checkup.[15] Testing shows no intestinal damage and normal blood levels, without FTT or weight loss. A common cause of toddler diarrhea is thought to be related excessive intake of juices that contain sucrose or sorbitol. The diarrhea results from excess water being pulled into the intestine, so limiting juice intake will be recommended in children whose intake exceeds daily recommendations.[31–33]

Toddlers and preschoolers with unexplained diarrhea or frequent loose stools should have medical evaluations to rule out known conditions that cause diarrhea, such as lactose intolerance, medication side effects, and celiac disease.

Celiac disease is an autoimmune disease that occurs in people who have an immune reaction to gluten, a component of wheat, rye, oats, and barley.[40,41] When gluten is consumed, the body's immune system attacks and

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damages the small intestine. This causes pain, diarrhea, and malabsorption. Celiac disease has a prevalence of 1 in 3,000 people within certain ethnic groups, such as those of Middle Eastern or Irish ancestry.[40] Celiac disease has a strong hereditary tendency and is also associated with chronic conditions such as Down syndrome, Turner syndrome, type 1 diabetes, juvenile arthritis, and others. It is also associated with a 3 to 10 times increased risk for developing another autoimmune disorder.[41]

Infants and toddlers tend to have more obvious symptoms which usually manifest in the gastrointestinal tract. Symptoms include, but are not limited to:

Vomiting
Bloating
Irritability
Poor growth
Abdominal distention
Diarrhea with very foul stools

Infants and toddlers can suffer from malnutrition, leading to poor growth in weight and/or height.

Symptoms of diarrhea and other digestive problems usually develop by 2 years of age. Confirmation of the condition is based on testing blood for the antibodies to gluten. After the blood test, the child may be asked to come in for an endoscopy. This test will determine whether the child has celiac disease. Nutrition intervention is based on modifying food and nutrient intake with a complete restriction of any foods with gluten. This list includes everything made with flour, such as bread and pasta, as well as foods with wheat, barley, or rye as an additive.[40,41] The allowed foods include rice, soy, corn, and potato flours. Oats are gluten free but may be contaminated with gluten from wheat mixed in. Meats, fruits, and vegetables are not restricted, but many processed foods use wheat flour for thickening. A child with celiac disease can have elimination of digestive symptoms once gluten is removed from the diet. The parents of preschoolers with celiac disease learn to be expert readers of food labels because intestinal damage recurs if gluten is eaten by mistake.

Autism Spectrum Disorders

The term *autism* is more accurately described as **autism spectrum disorders (ASD)** since it is a group of developmental disabilities. These conditions were previously defined as autistic disorder, pervasive developmental disorder not otherwise specified (PDD-NOS), and Asperger syndrome.[42,43] ASD is believed to be present at birth with symptoms apparent before age 3 years. (Refer also to Chapter 13 for a discussion of ASDs in older children.) The toddler and preschool years are when behavioral signs of ASDs are noted by families. Early screening and diagnostic evaluations are recommended by the AAP for those with suspected speech delays, repetitive behaviors, and social skill deficits.[43] Preschoolers with ASD are sensitive to all types of sensory information. This sensitivity often results in a rigid, self-restricted range of food choices, which can lead to parent and caregiver's concerns about the nutritional adequacy of the child's intake (Table 11.5). Nutritionists can offer families nutrition assessments of the child's food and nutrient intake and recommend nutrition interventions that assure the child's self-restricted food selections still meet their needs. Some families will restrict their child's intake of foods and beverages containing gluten and casein, in an attempt to improve behavior or gastrointestinal symptom.[43,44] However, these dietary manipulations have not been endorsed by the AAP or other professional organizations due to lack to evidence of their efficacy. One recent systematic review evaluated the use of gluten and casein-free diets in children with ASD and found the evidence to be limited and weak. These authors recommended that these products should be eliminated in children with ASD's diets only when there is evidence of a true food intolerance or allergy.[45] Milk substitutes to avoid casein may or may not meet the child's need for calcium, vitamin D, protein, or other nutrients. Food and nutrient intake recommendations for ASDs are the same as for any other child of the same age.[15] One study suggested that parent education along with experienced therapists could improve intake in dietary variety and decrease difficult mealtime behaviors in children ages 2–6 with ASD.[8]

autism spectrum disorders (ASDs) A group of developmental disorders characterized by deficits in communication, social interaction, and behaviors that meet diagnostic criteria in standardized testing, with onset generally before age 3.

spastic quadriplegia A form of cerebral palsy in which brain damage interferes with voluntary muscle control in both arms and legs.

Muscle Coordination Problems and Cerebral Palsy

Cerebral palsy (CP) is the terminology utilized for a wide range of conditions in which medical diagnoses, educational categories, and nutrition diagnoses differ. The prevalence of cerebral palsy is 1.5 to more than 4 per 1,000 children, with the highest risk found in children who were born prematurely.[46] The more premature an infant is, the more likely he or she will develop CP.[47]

Most children are diagnosed with CP by 1–2 years of age.[15] Some toddlers have muscle coordination problems combined with other developmental delays; others have a diagnosis of **spastic quadriplegia**.

Those at risk for, or confirmed with, cerebral palsy have a higher need for nutrition services than other toddlers and preschoolers, as growth and feeding problems worsen over time. Nutrition services start with nutrition assessments that include body composition indexes, such as fat and muscle stores.[29] Nutrition interventions are then

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Case Study 11.2 Early Intervention Services for a Boy at Risk for Nutrition Support

Roberto was born at 30 weeks' gestation and is now 25 months old. His parents' and extended family's main concern is that he is difficult to feed. "He cries and refuses to eat when offered meals, even those with his favorite foods."

The registered dietitian nutritionist (RDN) who consults at the early intervention program meets with the family, assesses Roberto, and reviews his medical records. The first step by the RDN is to observe Roberto's feeding by his mother and to evaluate his growth pattern and nutritional intake. The nutritionist and occupational therapist are concerned that Roberto is choking so easily, and recommend he undergo a swallowing study. Roberto does not attend the early intervention program for the next 3 weeks. The swallowing study indicates he is aspirating some of his liquids into his lungs and so oral feeding is not safe for the moment. He requires a gastrostomy for tube feedings. His parents learn how to feed him a specialized formula through the gastrostomy tube.

Nutrition services provided in the early intervention program are now documenting his growth as adjustments are made in his gastrostomy feeding schedule. Roberto gains weight over the next 6 months and becomes more interactive with the staff at the early intervention center. He begins to progress in his walking and speaking skills. The occupational and speech therapist work with his oral motor skills. A repeat swallowing study will be conducted in the near future. The goal is for Roberto to consume all of his nutrition by mouth once his swallowing is normalized and he is no longer at risk of aspirating his feedings.

Questions

1. What are the indications that Roberto needed to have a swallowing study?
2. Could the gastrostomy placement have been prevented if Roberto had gained weight?
3. Why is it important to have more than one health-care discipline involved in Roberto's care?



Vasileios Economou/iStock/Getty Images

based on these findings, which may include encouraging weight gain if body fat stores are low. An estimate of the energy needs for activity for a preschooler with CP may be higher or lower than their peers without CP.[47] A girl may expend higher energy in her efforts to coordinate walking while receiving physical therapy three days per week at school. Her activity may be lower if she is in a wheelchair most of the time.

A feeding assessment for a child with severe cerebral palsy called *spastic quadriplegia* might be necessary as part of the overall nutritional assessment.[10,47] The assessment may include an observation of eating to determine any restrictions in the type of foods that the child can eat, and whether coordinating muscles for chewing, swallowing, and/or using a spoon or fork are working well. Table 11.6 provides a food-intake record for a 4-year-old girl with spastic quadriplegia who does not walk and is receiving nutritional interventions for weight gain. Her meal pattern was adjusted because she tires easily while eating. She can chew foods such as fresh apples, but tires easily. She is able to consume a larger portion if the food is soft and does not require much chewing. Her weight gain has been slower than expected and her fat stores are low. The first step for her nutrition intervention is to use table foods that are easy for her to eat to meet her nutritional needs, including cooked rather than fresh vegetables and fruits, and to avoid hard-to-chew foods, such as roast beef or bagels. If her weight gain and growth continue to falter despite her caregivers providing the foods suggested in Table 11.6, she may require supplementation with commercially prepared beverages (Case Study 11.2). A child with poor weight gain and/or growth may require a tube feeding known as a **gastrostomy** tube.

Pulmonary Problems

Breathing conditions are examples of common problems in children with special health-care needs, which have major nutritional consequences. Breathing problems may carry a medical diagnosis such as **asthma**, or reoccur without any diagnosis, such as respiratory symptoms related to suspected allergies or infections.[48] Asthma is diagnosed in 2.6 percent of children under 4 years of age and in

gastrostomy Form of enteral nutrition support for delivering nutrition by tube directly into the stomach, bypassing the mouth, through a surgical procedure that creates an opening through the abdominal wall and stomach.

asthma Condition in which the lungs are unable to exchange air due to lack of expansion of air sacs. It can result in a chronic illness and sometimes unconsciousness and death if not treated.

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Table 11.6 Meal pattern and recommended foods for an underweight girl with feeding problems as a result of weakness

Meal Pattern: Small, Frequent Meals and Snacks to Prevent Tiredness at Meals	Recommended Foods That Are Easy to Chew, with Small Portions
Breakfast at home	½ cup oatmeal with added soft fruit, margarine, and brown sugar
Mid-morning snack	1 slice deli meat with 6 fl oz whole milk with Carnation Instant Breakfast added
Lunch (at preschool) Afternoon snack (at preschool)	½ cup soft-cooked sliced apples with added margarine
After-school snack	Cake-type cookie (frosting allowed)
Dinner	½ cup mashed potato with added margarine 3 Tbsp meatloaf 3 Tbsp soft-cooked carrots with added margarine
Bedtime snack	Chocolate cake with frosting and 4 fl oz whole milk

7.8 percent of children ages 5–9 years of age.[49] According to the Asthma and Allergy Foundation of America, non-Hispanic Black children are more than two times more likely to have asthma when compared to non-Hispanic White children.[50] Non-Hispanic Black children have higher mortality rates compared to non-Hispanic White children.[51] Approximately 59.2 percent of children under 5 years old had an asthma attack in 2020.[50] Asthma results in more emergency-room visits for children under 5 years—at 118.4 visits per 10,000 people—than it does in older children with asthma.[51] Asthma per se does not require nutrition services, but some children with asthma may also have food allergies. Families may restrict specific food groups such as dairy with the unsubstantiated belief that "milk increases mucus."[52] There is also an increased incidence of overweight and obesity in children with asthma.[53]

Nutrition diagnoses for a child with breathing problems are based on their impact on food and nutrient intake, such as excessive fluid intake, due to the difficulty with eating compared to drinking or involuntary weight loss as a result of frequent illness.[15] Nutrition services are needed because recurrent breathing problems increase nutritional needs, lower interest in eating, and can slow the growth rate (Case Study 11.2).[15]

bronchopulmonary dysplasia (BPD) Condition in which the underdeveloped lungs in a preterm infant are damaged so that breathing requires extra effort.

work of breathing (WOB) A common term used to express extra respiratory effort in a variety of pulmonary conditions.

Infants who are born prematurely are more likely to have breathing difficulties that carry into toddlerhood. Up to 80 percent of infants who are very underweight at birth can develop what is known as chronic lung disease of infancy or **bronchopulmonary dysplasia (BPD)**. BPD is thought to be the consequence of unresolved or unrepaired lung damage that occurs to a premature infant who receives supplemental oxygen and ventilator support in a neonatal intensive care unit.[54] Toddlers and preschoolers with BPD need extra energy due to the extra calories expended in breathing. Increased **work of breathing (WOB)** occurs with different pulmonary conditions and generally leads to low interest in feeding, partially as a result of tiredness.[54,55] Feeding difficulties have several causes in a toddler treated for BPD:[8]

- The normal progression of feeding skills is interrupted.
- Medications and their side effects contribute to high nutrition needs.
- Interrupted sleep and fatigue make hunger and fullness cues harder to interpret.

By the preschool years, the impact of BPD on slowing the rate of weight gain is usually clear. Exposure to common respiratory illnesses, which are minor in typical children, can require a trip back to the hospital for some children with BPD. Increased frequency of infections adds another limitation to proper weight gain and growth. Neither the CDC growth chart nor the WHO growth chart may be helpful in predicting a child with BPD's growth pattern, but periods of health are usually accompanied by an increase in weight and appetite.

Food and nutrient intake recommendations for toddlers with BPD are similar to those for children with muscular weakness (Table 11.6). Small, frequent meals with foods that are concentrated energy sources are needed. Easy-to-eat foods may still be recommended so that fatigue from meals is low. If the toddler with breathing problems does not gain weight as a result of dietary interventions (Table 11.6), the next step would be to add homemade or commercially prepared nutritional supplements to meet the higher energy and protein needs. These supplements, such as Pediasure® or KinderCal®, are designed to meet the needs of children ages 1–10 years old. They are also a source of vitamins and minerals. Proper nutrition and growth is essential for toddlers and preschoolers with BPD as new lung tissue can grow until about 8 years of age. This lung growth allows for the resolution of BPD.[54,56]

Food Allergies and Intolerance

A true food allergy is a response by the body's immune system to a food or food additive. True food allergies are estimated to be present in 2–8 percent of children.[57] Food allergies are usually identified in toddlers and preschoolers as allergy testing in infancy is not useful due to the incomplete development of the immune system.[15,47] True

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food allergies can result in life-threatening episodes of **anaphylaxis**.[15,57] Examples of food allergies that may result in anaphylaxis for some children include the following:[57]

- Cow's milk
- Eggs
- Wheat
- Peanuts
- Tree nuts
- Soy
- Crustacean shellfish

Cow's milk protein allergy rarely persists into the toddler and preschool years. However, when cow's milk protein allergy does persist, symptoms in the toddler and preschool years may appear as more general allergy symptoms, such as asthma or skin rashes.[57] Other food allergies are often present in a child with confirmed cow's milk protein allergy, with, for example, 35 percent reacting also to oranges or 47 percent reacting also to soy milk.[15,57]

True food allergies can greatly affect the family. Strict and complete avoidance of the food that causes the allergy is required. This abstinence includes all settings, such as eating nothing prepared at bake sales when the food ingredients are unknown. An extensively restricted therapeutic intervention for a preschooler includes how nutrient and energy adequacy is assured. Parents may diagnose their child/children with food allergies following perceived food reactions. A study by Abrams and Sicherer reported 35 percent of parents believed their child had food allergies and restricted foods potentially resulting in nutrient deficiencies.[58] It is important for physicians and health-care workers to properly diagnose and manage food allergies. There are many resources available for caregivers who have children with food allergies, such as The Food Allergy Research and Education Network (www.foodallergy.org). For children at risk for anaphylaxis, parents and caregivers should be given instruction in emergency lifesaving procedures and use of an injected form of epinephrine.[15,57]

Dietary Supplements and Herbal Remedies

> "It is better to take food into the mouth than to take worries into the heart."
>
> —Yiddish saying

Parents and care providers of children with special health-care needs may seek out additional or nontraditional health and nutritional products designed for adults. The family that is having difficulty finding effective treatment for a child is most at risk for inappropriate or ineffective alternative products. Foods and supplements claiming probiotic benefits for adults are expanding into use for children, even though they are not intended for chronically ill young children. Physicians recommend that their appropriate use in young children be safely limited, in spite of their expansion into the marketplace.[59] Use of dietary supplements in children with chronic conditions is more common than in healthy children, as many families take dietary supplements not prescribed or discussed with health-care providers.[60] Examples of dietary supplements are vitamins, minerals, botanicals, amino acids, and fatty acids.[60] Parent coalitions and advocacy groups are excellent sources of networking for families, but they can also be sources of nutritional claims for products and food and nutrient intake regimens that have no evidence-based research.[61] Down syndrome, for example, is a disorder for which nutritional supplementation has been marketed to parents. No specific nutrients, combinations of nutrients, or herbal remedies have been shown to improve the intellectual functioning of individuals with Down syndrome.[18] The National Down Syndrome Society (www.ndss.org) cautions parents about the ineffectiveness of nutrient and herbal supplements to discourage their use.[62] It is important for care providers to be encouraged to discuss with a trusted health professional whatever supplements or OTC products are of interest before giving them to young children.

COVID-19 Pandemic

The COVID-19 pandemic has implications that will affect the nutritional needs of most children for years to come. School closures have led to the interruption of programs allowing children to receive free and subsidized school lunches and healthy snacks, exposing millions of children to food insecurity. It is currently unknown to what level this pandemic will impact the nutritional status of children around the globe. Some of the risks will be malnutrition, obesity, undernutrition, and hidden hunger due to micronutrient deficiencies, especially among the vulnerable groups.[63] Currently, the USDA is granting states significant program flexibilities and contingencies to best serve program participants across their 15 nutrition programs.[64,65]

Sources of Nutrition Services

Most young children are healthy and do not see nutritionists as a part of routine care. Low-income families with young children are more likely to see a nutritionist than higher-income families, because of their participation in WIC. Registered dietitian nutritionists with training in pediatrics are best qualified to provide nutrition therapy to toddlers and preschool children with chronic conditions. Leadership Education in Neurodevelopmental and Related Disabilities (LEND) training programs are funded in part by the Maternal and Child Health Bureau and administered by the Health Resources and Service's Administration to improve the health of infants, children, and adolescents

anaphylaxis Sudden onset of a reaction with mild to severe symptoms, including a decrease in ability to breathe, wheezing, coughing or tightness in chest, which may be severe enough to cause a coma.

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with disabilities. These programs train nutritionists and other health professionals to provide interdisciplinary, family-centered care to children with neurodevelopmental disabilities.[66] These programs also receive funding from legislation titled "Combating Autism Act of 2006" (Public Law 109–416),[67] designed to enable all infants, children, and adolescents who have, or are at risk for developing, ASD, and other developmental disabilities to reach their full potential by early screening, identification, and access to services.

Programs in which nutrition care may be accessed include the following:[11,66,67]

- State programs for children with special health-care needs
- Early intervention programs (age 0 up to 36 months)
- Early childhood education programs (IDEA, ages 3–5 years)
- Head Start; regular program or special-needs category (ages 3–5 years)
- Early Head Start; regular program or special-needs category (0 up to 36 months)
- WIC
- Low-birthweight follow-up programs
- Child care feeding programs (USDA)

These programs are described in Chapters 8 and 10. Efforts to increase program accessibility come from state and federal governmental offices, toll-free outreach services, and websites. Specific outreach programs to locate toddlers and preschoolers at risk are funded in each state, under names such as "Child Find."[67] Every child at risk is eligible for a screening so caregivers are encouraged to contact neighborhood public school or local health department to locate appropriate services.

Key Points

1. Toddlers and preschoolers with special health-care needs may have alterations in their nutritional needs, growth, and feeding skills. Early intervention programs and early childhood education programs are essential to help these children meet their intellectual, developmental, and growth potentials.
2. Toddlers and preschoolers with special health-care needs are quite varied in their nutrition needs, but the basic concepts of supporting growth, typical feeding skill development, and meeting nutrition needs for age and activity still apply.
3. Families of children with special health-care needs may use unsubstantiated OTC products, such as herbal supplements, vitamins, or probiotic-containing foods for adults, which can be dangerous for young children.
4. Failure to thrive is often the reason children with special health-care needs enter medical, educational, and developmental services. Such cases of failure to thrive cannot be corrected with additional energy, as it can be in children without special health-care needs. Unusual growth patterns can be signs of conditions that are not directly related to nutrition.
5. Medical conditions with nutritional implications found in toddlers and preschoolers with special health-care needs are autism spectrum disorder, ADHD, cerebral palsy, BPD, developmental delay, celiac disease, and food allergies.

Review Questions

1. What is an accurate statement about services for a boy with Down syndrome who has difficulty chewing when he turns 3 years old?
   a. He is now eligible to start receiving supplementary social security if his family meets the income requirements.
   b. He needs speech therapy to address his difficulty chewing.
   c. He is no longer eligible for early childhood programs under IDEA.
   d. His chewing difficulty cannot be included in his nutrition services, as it is a typical component of his underlying syndrome.
2. What is an accurate statement about a preschool girl who has a diagnosed milk-protein allergy?
   a. If she attends a public day care that participates in the USDA Child Nutrition Program, her family has to provide her lunch for her safety.
   b. Only if this allergy is a feature of an underlying condition is she considered a child eligible for educational modifications under IDEA.
   c. Her allergy would still let her have ice cream as a special treat on her birthdays.
   d. She may grow out of this allergy as she gets older.

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3. A 4-year-old girl with asthma does not have food allergies. Her asthma routine requires a home breathing machine and two prescribed medications. Which statement is accurate about her nutrition needs?
   a. Her diagnosis is one of the more common types of special needs and is best managed by a reduced-calorie diet to compensate for restricted activity.
   b. Compliance with her nutrition recommendations can prevent emergency-room visits for flare-ups.
   c. Her prescribed medications could impact her appetite and growth and so this requires nutrition services.
   d. Asthma is likely to interrupt the normal progression of eating skills in a young child.
4. Feeding and eating problems do *not* require nutrition services under which of these conditions?
   a. When a 3-year-old boy has a food jag and refuses to eat foods he usually likes.
   b. When the parents or caregivers are concerned that a toddler wants to drink milk or juice but refuses solid foods such as fruit.
   c. When a 3-year-old child is diagnosed with ASD and is entering a behavioral management program.
   d. When a 3-year-old child is diagnosed with gastroesophageal reflux and prescribed medications again.

Questions 5, 6, and 7 concern growth assessment. Determine whether each is true or false.

5. Any child with a chronic condition should have a growth assessment as part of determining nutrition status.

   _____ True _____ False
6. A 4-year-old boy with cerebral palsy would have normal growth on the CDC growth charts.

   _____ True _____ False
7. A 21-month-old boy has a growth pattern that plots lower on the standard CDC growth chart than on the WHO growth charts; his growth is plotted incorrectly.

   _____ True _____ False
8. Briefly describe why measuring head size is a part of a nutritional assessment for a toddler or preschooler with a suspected special health-care need.
9. Identify two examples of when standard nutrition guidance for healthy toddlers and preschoolers must be modified for a preschool-age child with special health-care needs.
10. Identify two examples of when a vitamin or mineral supplement has to be a part of a nutrition services plan.

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12

Child and Preadolescent Nutrition

Prepared by Beth L. Leonberg

Learning Objectives

After studying the materials in this chapter, you should be able to:

12.1 List two Healthy People 2030 objectives that specifically relate to middle childhood and preadolescence.

12.2 Describe the expected pattern of growth of a healthy child during middle childhood and preadolescence.

12.3 Define body mass index (BMI) rebound and describe the consequences of early BMI rebound.

12.4 Explain what influences energy needs of school-age children.

12.5 List two strategies for preventing dental caries in school-age children.

12.6 Describe prevention strategies for overweight/obesity in school-age children.

12.7 Describe the components of a healthy diet during middle childhood and preadolescence as recommended by health and professional organizations and agencies.

12.8 List two strategies that parents/caretakers can employ to encourage school-age children to be more physically active.

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12.9 List three strategies that school health programs can use to promote healthy eating.

12.10 Describe one component of the USDA's Child Nutrition Program and explain how this specific program addresses the health of school-age children.

Introduction

This chapter focuses on the impact of nutritional status on the growth and development of school-age and preadolescent children. During this period, children continue to grow physically at a steady rate, but development from a cognitive, emotional, and social standpoint is considerable. This period in a child's life prepares them for the physical and emotional demands of the adolescent growth spurt. Having family members, teachers, and others in their life who model healthy eating and physical activity behaviors will better equip them for making good choices during adolescence and later in life.

Definitions of the Life-Cycle Stage

Middle childhood generally describes children between the ages of 5 and 10 years. **Preadolescence** generally describes girls ages 9–11 years and boys ages 10–12 years. Both stages of growth and development are also referred to as *school-age*.

Importance of Nutrition

Adequate nutrition continues to play an important role in ensuring that children reach their full potential for growth, development, and health during the school-age years. Nutrition problems that may occur during this period include iron-deficiency anemia, undernutrition, and dental caries. Regarding weight, problems at both ends of the spectrum may develop during this age; the prevalence of obesity increases, but the beginning of eating disorders may also be detected in some school-age and preadolescent children. Therefore, providing adequate nutrition and establishing healthy eating behaviors can help prevent immediate health problems, as well as reduce the risk of the child developing a chronic condition, such as obesity, type 2 diabetes, and/or cardiovascular disease later in life.[1] Adequate nutrition, especially eating breakfast, has been associated with improved academic performance in school and reduced tardiness and absences.[2] Meeting energy and nutrient needs, addressing common nutrition problems, and preventing nutrition-related disorders while establishing healthy eating and physical activity habits will be discussed later in this chapter.

12.1 Tracking Child and Preadolescent Health

In 2020, there were approximately 73 million children in the United States under 18 years of age, making up about 22 percent of the population; 24.3 million of them were between the ages of 6 and 11 years.[3] The National Survey of Children's Health provides data on a wide range of child health indicators.[4] For example, in 2019–2020, approximately 18 percent of children were living below the federal poverty level, but there were significant differences by race. Approximately 34 percent of non-Hispanic Black, and 27 percent of Hispanic children lived in households with incomes below the poverty level, compared to approximately 10 percent of non-Hispanic White children and 14 percent of Asian American children.[3] While 93 percent of U.S. children have some form of health insurance, the rate of children who are uninsured is almost two times greater for Hispanic White children than for non-Hispanic White children. Access to medical care for children varies by race as well, with 84 percent of White children having one or more preventative care visit, compared to 79 percent of Black, 76 percent of Hispanic children, and only 74 percent of Asian American children.

Disparities in nutrition status indicators exist among races and ethnicities. For instance, the odds of being obese are significantly higher for non-Hispanic Black children and Mexican American children compared with non-Hispanic White children.[5] In the discussions that follow regarding nutrition during childhood, the recommendations must always be considered in the context of the individual child's environment.

middle childhood Children between the ages of 5 and 10 years; also referred to as "school-age."

preadolescence The stage of development immediately preceding adolescence; 9–11 years of age for girls and 10–12 years of age for boys.

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Table 12.1 Healthy People 2030 objectives related to school-age children[6]

Healthy People 2030 Objective		Baseline	Target
AH-04	Increase the proportion of students participating in the School Breakfast Program.	23.6%	34.9%
AH-R03	Increase the proportion of eligible students participating in the Summer Food Service Program.	Research	
NWS-04	Reduce the proportion of children and adolescents with obesity.	17.8%	15.5%
PA-09	Increase the proportion of children who do enough aerobic physical activity.	25.6%	30.4%
PA-R02	Increase the proportion of parents who follow AAP recommendations on limiting screen time for children aged 6–17 years.	Research	
ECBP-D02	Increase the proportion of schools that don't sell less healthy foods and drinks.	Developmental	
NWS-02	Eliminate very low food security in children.	0.59%	0.00%

Source: U.S. Department of Health and Human Services.

Healthy People 2030

Several objectives in the Healthy People 2030 document are specific to children's health and well-being. Table 10.1 lists Nutrition and Weight Status (NWS) objectives related to food and nutrient composition that pertain to the population aged 2 years and older. Table 12.1 lists additional Healthy People 2030 objectives that are pertinent to a discussion of middle childhood and preadolescence.

12.2 School-Age Growth and Development

During the school-age years, the child's growth is steady, but the growth velocity is not as great as it was during infancy or as great as it will be during adolescence. The average annual growth during the school years is 7 lb (3–3.5 kg) in weight and 2.5 in. (6 cm) in height.[7] Children of this age continue to have spurts of growth that usually coincide with periods of increased appetite and intake. During periods of slower growth, the child's appetite and intake will decrease. Parents should not be overly concerned with this variability in appetite and intake in their school-age children.

Periodic monitoring of growth continues to be important to identify any deviations in the child's growth pattern. Children should continue to be weighed on calibrated scales without shoes and in lightweight clothing. The child's stature or standing height should be measured without shoes and utilizing a wall-mounted stadiometer (Photo 10.3). A stadiometer consists of a non-stretchable tape on a flat surface like a wall, with a movable right-angle headboard. The child's heels, buttocks, shoulders, and back of the head should be touching the wall or flat surface, and the child should be instructed to stand tall, looking straight ahead with arms by the sides, during the measurement. Both weight and height should be plotted on the appropriate 2000 Centers for Disease Control and Prevention (CDC) growth charts. Body mass index (BMI) should be calculated from measured weight and height and evaluated on the appropriate CDC growth chart.

The 2000 CDC Growth Charts

The "CDC Growth Charts: United States" are the recommended tool for monitoring the growth of a child.[8] The appropriate growth charts are sex-specific for children 2–20 years of age and allow the user to plot weight-for-age, stature-for-age, and BMI-for-age. They can be downloaded from the CDC website: www.cdc.gov/growthcharts/cdc_charts.htm. As described in Chapter 10, the growth charts are based on data from the second and third cycles of the National Health and Examination Survey (NHES) and the National Health and Nutrition Examination Surveys (NHANES) I, II, and III. However, weight data for children greater than 6 years of age who participated in NHANES III were not included because there was a known higher prevalence of overweight for these ages. Incorporating this information into the growth charts would reflect an unhealthy standard.[9] Children whose BMI-for-age is greater than or equal to the 85th percentile but less than or equal to the 94th percentile are classified as overweight, while children whose BMI-for-age is greater than or equal to the 95th percentile are classified as obese.[10,11]

A chart for weight-for-stature up to a height of 48 in. (122 cm) for the younger school-age child is available on the CDC website. As with the toddler and preschooler, it is the child's pattern of growth over time that is important rather than any single measurement (Figure 12.1). The tracking of BMI-for-age percentile is an important screening tool for overweight and obesity as well as undernutrition (Figure 12.2). Using the correct age of the child when plotting on the growth charts will help avoid plotting errors and possible misinterpretations of growth trends.

The American Society of Parenteral and Enteral Nutrition and the Academy of Nutrition and Dietetics (AND) advocate use of *z*-scores to evaluate how far a child's measured weight, height, or BMI deviates from the population mean.[12] A *z*-score is a statistical measure of how many standard deviations the value lies from the mean. Negative *z*-scores reflect values below the mean, while positive *z*-scores reflect values above the mean. By following the

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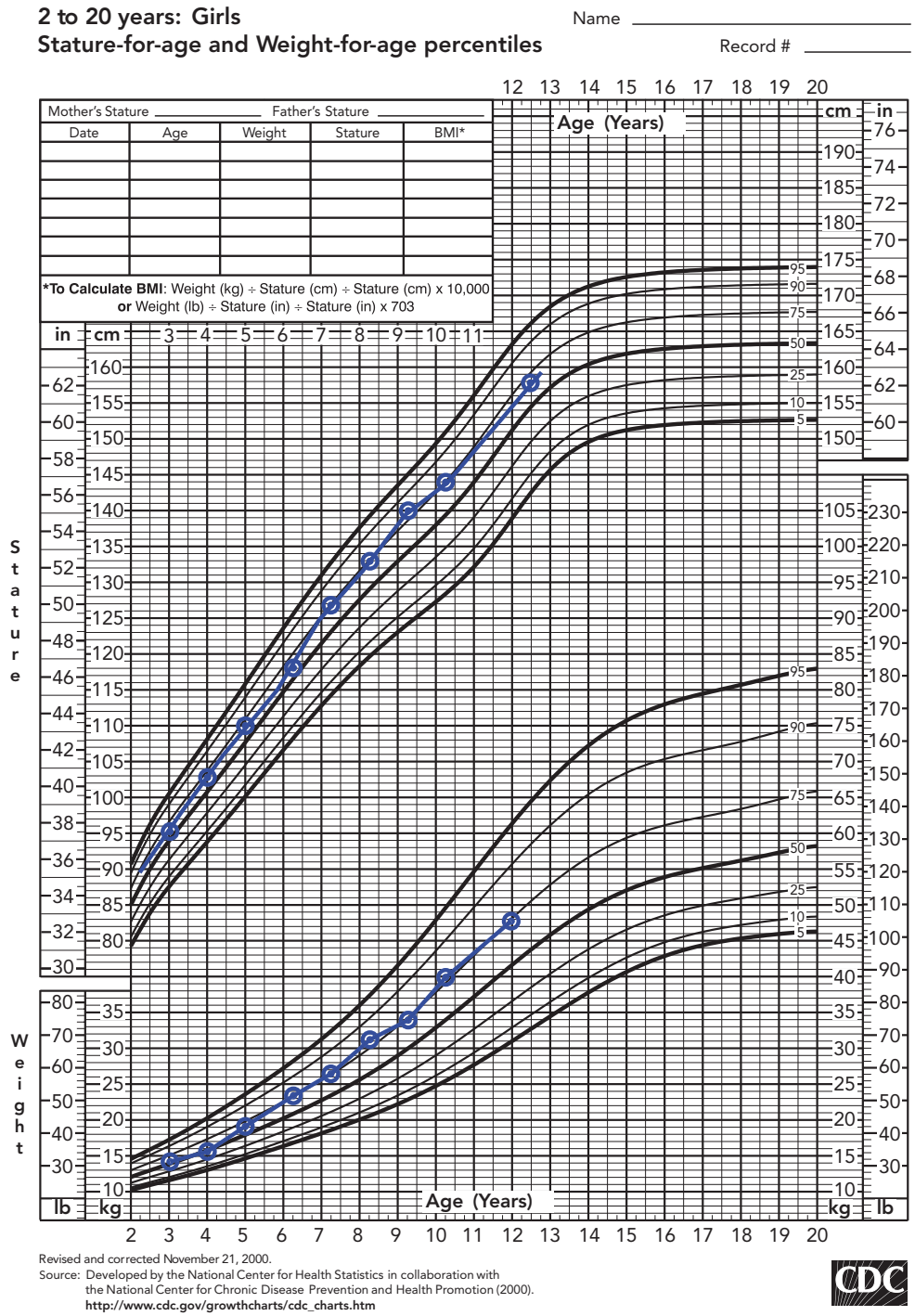


Figure 12.1 2–20 years: Girls' stature-for-age and weight-for-age percentiles.[8]

child's *z*-score, it is easy to see whether the child's growth is deviating farther from the mean; this is especially helpful for children who are obese.

WHO Growth References

In 2007, the World Health Organization (WHO) released growth references for older school-age children and adolescents, including height-for-age, weight-for-age, and BMI-for-age.[13] Unlike the WHO Child Growth Standards for 0–5 years, which were based on prospective growth data, the growth reference for school-age children and adolescents was constructed using existing historical data. In most clinical settings in the United States, the CDC growth charts are used to monitor the growth of children.

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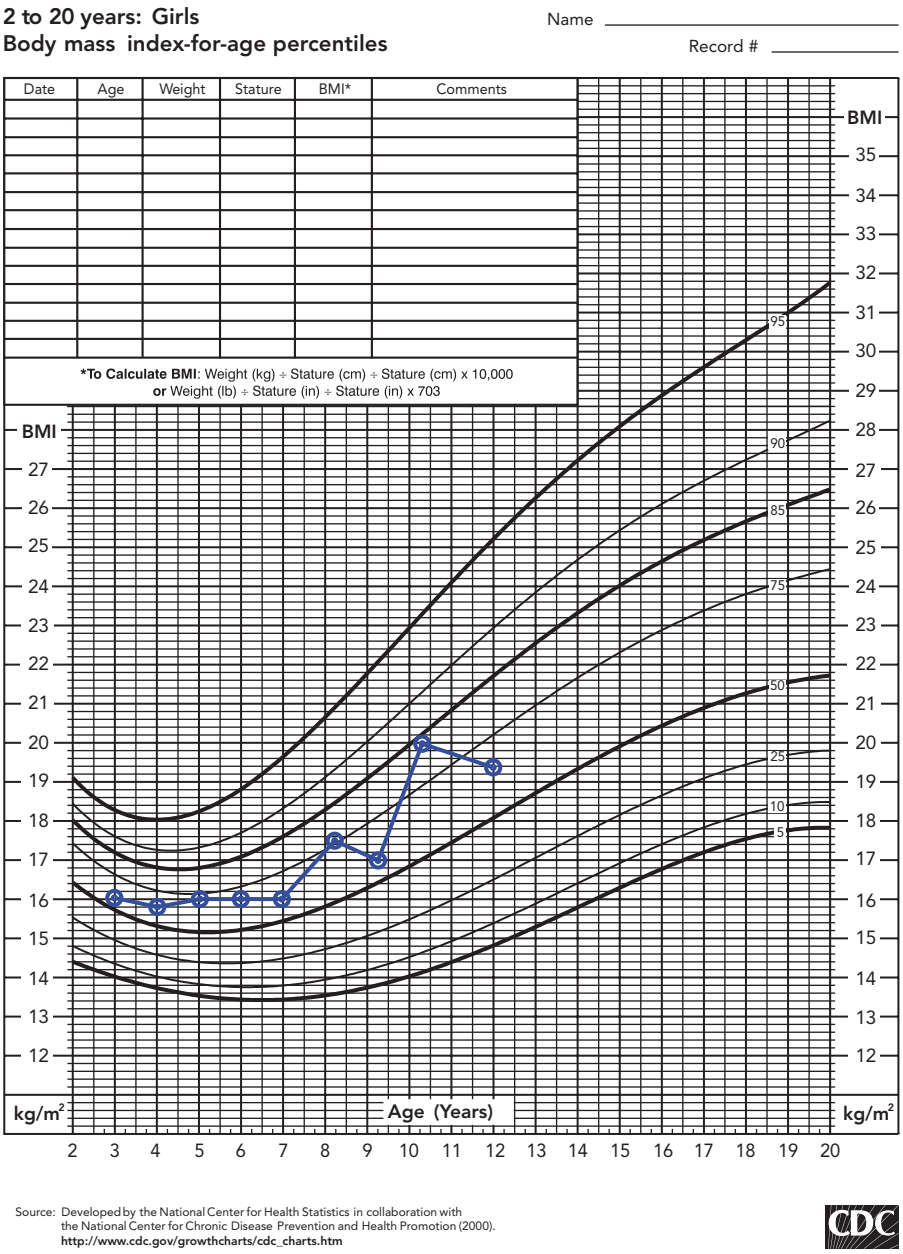


Figure 12.2 2–20 years: Girls' body mass index-for-age percentiles.[8]

12.3 Physiological and Cognitive Development of School-Age Children

Physiological Development

During middle childhood, muscular strength, motor coordination, and stamina increase progressively.[7] Children can perform more complex pattern movements, affording them opportunities to participate in activities such as dance, sports, gymnastics, and other physical activities.

During the early childhood years, body fat reaches a minimum of 16 percent in girls and 13 percent in boys. Percent body fat then increases in preparation for the adolescent growth spurt. This increase in percent body fat, which usually occurs on average at 6 years of age, is called BMI rebound, or adiposity rebound, and is reflected in the BMI-for-age growth charts.[14] An early BMI rebound, before age 5 years, has been associated with an increased risk of overweight and obesity.[15] The increase in percent body fat with puberty is earlier and greater in girls than in boys (19 percent for girls versus 14 percent for boys).[1] During middle childhood, boys have more lean body mass per centimeter of height than girls do. These differences in body composition become more pronounced during adolescence.[1] It is important to understand that BMI is not constant throughout childhood. This is because height is a component of the formula for BMI (weight in kilograms divided by height in meters squared),

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and a child's height is constantly increasing as they grow. Plotting BMI-for-age percentile on the growth charts is the only way to know if a child's BMI is outside the normal range for their age. The goal for children is not to strive for a certain range of BMI values, as it is in adults, but rather, to have a BMI-for-age percentile within the normal range.

With the increase in body fat, preadolescents, especially girls, may be concerned that they are becoming overweight. Parents need to be aware that an increase in body fat during this stage is part of normal growth and development. Parents need to be able to reassure their child that these changes are most likely not permanent; parents also need to be careful not to reinforce a preoccupation with weight and size. Boys may become concerned about developing muscle mass and need to understand that they will not be able to increase their muscle mass until middle adolescence (Chapter 14).[1]

Cognitive Development

The major developmental achievement during middle childhood is self-efficacy, the knowledge of what to do and the ability to do it. During the school-age years, children move from a developmental stage characterized by magical thinking and egocentrism to one of concrete operations.[7] This stage is characterized by being able to focus on several aspects of a situation at the same time; being able to have more rational cause/effect reasoning; being able to classify, reclassify, and generalize; and a decrease in egocentrism, which allows the child to see another's point of view. Schoolwork becomes increasingly complex as the child gets older. School-age children also enjoy playing strategy games, displaying growing cognitive and language development.

During this stage, the child is developing a sense of self. Children become increasingly independent and are learning their roles in the family, at school, and in the community.[1] Peer relationships become increasingly important, and children begin to separate from their own families by spending the night at a friend's or relative's house. More and more time is spent watching television, playing video games, and being on the computer and Internet. Older children may be able to walk or ride a bicycle to a neighborhood store and purchase snack items. Thus, influences outside the home environment play an increasing role in all aspects of the child's life.

Development of Feeding Skills and Eating Behaviors

With increased motor coordination, school-age children develop increased feeding skills. During this period, the child masters the use of eating utensils, can be involved in simple food preparation, and can be assigned chores related to mealtime such as setting the table. By performing these tasks, the child learns to contribute to the family, which boosts developing self-esteem. The complexity of the tasks can be increased as the child grows older. For example, a 6-year-old may be responsible only for putting napkins and silverware on the table, while a 10-year-old may also put out plates, pour beverages, and get out the margarine or salad dressing. At the same time, the child is learning about different foods, simple food preparation, and some basic nutrition facts.

Eating Behaviors Parents and older siblings continue to have the most influence on a child's attitudes toward food and food choices during middle childhood and preadolescence. The eating behaviors and cultural food practices and preferences of parents will influence the child's food likes and dislikes. The feeding relationship between parent and child, as described in Chapter 10, still applies to the school-age child. Parents are responsible for the food environment in the home, what foods are available, and when they are served. The child is responsible for how much they eat.[16] Parents need to continue to be positive role models for their children in terms of healthy eating behaviors. They also need to provide the necessary guidance so that the child will be able to make healthy food choices when away from home.

Family Mealtime Although the trend over the last 20 years is for more meals to be consumed away from home, families should try to eat meals together. When children are involved in school-related activities, eating together is often difficult to achieve because of the family members' hectic schedules.[17] Regardless of the challenges, eating together as a family should be encouraged, allowing time for conversation (Photo 12.1). Excessive reprimanding and arguments should be avoided during mealtime.



Monkey Business Images/Shutterstock.com

Photo 12.1 A family enjoying mealtime together.

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Family mealtimes allow parents and caregivers to model healthy eating behaviors and have been shown to improve the nutritional quality of children's meals, as well as weight status.[18]

A recent meta-analysis of 57 research studies conducted in different countries confirmed the association between more frequent family meals and the nutritional health of children as measured by better overall diet quality, better healthy diet, less unhealthy diet, and lower BMI.[19] Children who ate more frequent family meals were more likely to eat more fruits and vegetables and less likely to eat sugar-sweetened beverages, fast food, and salty or sweet snacks. These children had a higher overall diet quality and lower BMI; the BMI effect was seen even when socioeconomic status was controlled in the studies.

Outside Influences School-age children spend more and more time away from home, which is an important part of normal growth and development. Peer influence becomes greater as the child's world expands beyond the family. The increased peer influence extends to attitudes toward foods and food choices.[20] Children may suddenly request a new food or refuse a previous favorite food, based on recommendations from a peer.

Teachers and coaches have an increasing influence on the child's attitudes toward food and eating behaviors. Nutrition should be part of the health curriculum, and what is learned in the classroom should be reinforced by foods available in the school cafeteria. Vending machines, often present in schools as a source of extra school funding, can also reinforce good nutrition with appropriate choices, or they can be a source of high-fat, high-sugar foods and beverages.

Media Influence In their expanding world, children come under the influence of the media. Children want to try foods they see advertised on television or the Internet. One study analyzed the commercials aired during Saturday morning television programming and found that 49 percent of all advertisements were for food (Photo 12.2).[21] Of these food advertisements, 91 percent were for foods or beverages high in fat, sodium, or added sugars or were low in nutrients, which conflict with the recommendations of the U.S. Department of Agriculture's MyPlate (Chapter 1).[21,22]

Multiple systematic reviews have shown that screen advertising of foods through television, social media, and advergaming is associated with increased food intake and poor dietary choices.[23–26] Food advertising on television and advergames is associated with an average increased intake of 60 kcal and a higher BMI.[23] Children exposed to marketing of unhealthy foods had a higher likelihood of choosing energy-dense, low-nutrition foods and beverages shortly after exposure.[26] In addition to screen marketing, research has shown that distributing movie and television character toys has a negative impact on the food choices of children.[27]

As a result of the documented influence of marketing on children, the American Academy of Pediatrics issued a Policy Statement on digital advertising to children in 2020.[28]



Beth Leonberg

Photo 12.2 Television characters and other media have a large influence on children's food choices.

They state "School-aged children and teenagers may be able to recognize advertising but often are not able to resist it when it is embedded within trusted social networks, encouraged by celebrity influencers, or delivered next to personalized content." Their statement includes recommended actions for parents, health-care providers, industry and policy makers. They encourage parents to actively monitor their children's use of media and routinely engage in conversations with them to help them how to analyze the ads they see. Among their recommendations to industry and policy makers is a call to ban all advertising to children under 7 years old, and to clearly label as advertising that which is aimed at older children and teenagers. In addition, they specifically call for them to "Reduce advertising of unhealthy foods and beverages to children and teenagers, particularly targeted advertising that exacerbates disparities when combined with structural sources of inequality (e.g., Health food scarcity, public underinvestment in opportunities for exercise or play)." This last recommendation calls out the disparities seen in urban food swamps, where access to healthy food options is limited.

Snacking Snacks continue to contribute significantly to a child's daily intake during middle childhood; children cannot consume large amounts of food at one time and therefore need snacks to meet their nutrient needs.

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However, research shows that snacking has increased significantly in the last 30 years, with the greatest increase in salty snacks and candy, and the greatest overall snack calories coming from desserts and sweetened beverages.[29,30] A recent study of the snacking behavior of U.S. children compared to those of other cultures revealed that it provided approximately 25 percent of the daily calories of children between the ages of 4 and 13 years.[31] In contrast, snacking in Australia provided as many as 33 percent of the children's daily calories, while in Mexico and China snacks provided only 15 percent and 10 percent, respectively. Snacking also contributes to excess intake of added sugars, saturated fat and sodium, which continue to be problematic for U.S. children. According to the 2020–2025 Dietary Guidelines for Americans, more than 75 percent of children aged 5–13 are exceeding the recommended intakes of these nutrients.[32]

Many children prepare their own breakfasts or afterschool snacks. These children need to have a variety of foods available to them, be equipped with nutrition education for making their own food choices, and have some age-appropriate knowledge and skill in food preparation—assuming, of course, that the family has adequate access to food.

Food Preference Development, Appetite, and Satiety Food preference development, appetite, and satiety in young children were thoroughly discussed in Chapter 10. Researchers have described the innate ability of young children to internally control their energy intake and their responsiveness to energy density. The internal controls can be altered by external factors, such as child-feeding practices. Studies in 9- to 10-year-old children found that these older children were not as responsive to energy density as were young preschool-age children.[33] External factors such as the time of day, the presence of other people, and the availability of good food begin to override the internal controls of hunger and satiety as children get older.

Research has emphasized the importance of parents assuming responsibility for providing a healthy food environment, but not being overly controlling or restrictive of their child's intake.[34–36] When parents try to control their children's intake, especially by restricting their access to food, children become less able to regulate their intake to meet their needs and are more likely to become overweight.[33–35] Parents are encouraged to adopt a responsive feeding style, allowing the child to eat in response to their internal hunger and satiety cues.

Body Image/Excessive Dieting Parents who had difficulty controlling their own intakes seemed to impose more restrictions on their children. The more the parent is concerned with their own weight and with the risk of their children becoming overweight, the more likely they are to employ restrictive child-feeding practices. A study of mothers and their 5-year-old daughters found that this transfer of "restrictive" eating practices may begin as early as the preschool age.[37] These researchers hypothesize that chronic dieting and dietary restraints, which are commonly seen in adolescent girls and young women, may have their beginnings in the early regulation of energy intake and may be related to the amount of parental control exerted over the child's eating.[38] By imposing controls and restrictions over their daughters' intakes, mothers may actually be promoting the intake of the less healthy foods they are trying to limit.[39] Similar results were found in 5-year-old girls whose parents restricted palatable snack foods.[40] Not only did parental restriction promote the consumption of these less healthy foods by the young girls, but also these children reported feeling badly about eating these foods. While this research has typically focused on the mother–daughter relationship, it's important to note that similar interactions can occur between parents and children of any gender.

Young girls seem to have a preoccupation with weight and size at an early age. With the normal increase in body mass index or body fat in preadolescence, many girls and their mothers may interpret this phenomenon of normal growth and development as a sign that the child is developing a weight problem. Early "dieting" may be a risk factor for the development of obesity.[41] Dieting, which imposes restrictions, is similar to controlling child-feeding practices, which restrict children's intake. Both methods ignore internal cues of hunger and satiety. These types of child-feeding practices not only contribute to the onset of obesity and possibly a nutritionally inferior diet but also may be contributing to the beginnings of eating disorders. A longitudinal study of dietary habits of children of mothers with eating disorders, either anorexia nervosa (AN) or bulimia nervosa (BN), showed differences in both total calorie intake and macronutrient distribution of the diet, when compared to children of healthy mothers.[42] In this study, children between the ages of 3 and 9 years, whose mother had either AN or BN, consumed more total calories over the day, while those whose mother had BN also consumed a greater percentage of their calories as carbohydrates. These findings lend further support to the relationship between parental attitudes about food and the dietary habits of their children. It is important to note that, while much research has been done on girls and eating disorders, boys may experience body dysmorphia and eating disorders as well. Eating disorders are discussed in more detail in Chapter 15.

Many studies of ethnic differences in body image and body-size preferences have been conducted, hypothesizing that there are ethnic and gender differences in these parameters. The research conducted to date is not conclusive. One study of men and women of four ethnicities/races—Black, Latinx, Asian American, and White—found that ethnicity alone did not influence the preference for body shapes or tolerance for obesity.[43] In working with individual families, however, it is important to try to assess their health beliefs and their preference for body size, which may impact their readiness for nutrition counseling.

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12.4 Energy and Nutrient Needs of School-Age Children

Dietary Reference Intakes (DRIs) tables are provided at the end of this book. Children need a variety of foods that provide enough energy, protein, carbohydrate, fat, vitamins, and minerals for optimal growth and development.[1]

Energy Needs

Energy needs of school-age children reflect the slow but steady growth rate during this stage of development. Energy needs of an individual child are dependent on the child's activity level and body size. Equations for estimating energy requirements have been developed as part of the DRIs, based on a child's gender, age, height, weight, and physical activity level (PAL).[44] Estimated energy expenditure (EER) has been defined as total energy expenditure plus kilocalories for energy deposition. Categories of activity are defined in terms of walking equivalence (Table 12.2). For example, an 8-year-old girl who weighs 56.4 lb (25.6 kg) and is 50.4 in. (128 cm) tall will require 1,409 kcal per day if inactive, 1,551 kcal per day if she is low-active, 1,415 kcal per day if active, and 1,824 kcal per day if very active. Energy allowances based on body weight are lower for school-age children than for toddlers and preschoolers. The decrease in the energy requirement per kilogram of body weight is a reflection of slowing growth rate. In addition to the DRI equations for estimating calorie requirements for children, online tools are available on websites such as MyPlate.gov and the U.S. Department of Agriculture (USDA)/Agriculture Research Service's Children's Nutrition Research Center (refer to the "Resources" section).

Protein

Based on the DRIs, the recommended protein intake for school-age children is 0.95 g of protein per kg body weight per day for 4- to 13-year-old girls and boys.[43] School-age children can meet this recommendation by consuming healthy dietary patterns that follow the MyPlate recommendations and the Dietary Guidelines for Americans, 2020.[22,45] Vegetarian diets are also appropriate for school-age children if they provide sufficient energy, complementary protein foods, a variety of foods, and adequate levels of intake of vitamins and minerals.[1] By meeting an individual child's energy needs, protein is spared for tissue repair and growth.

Table 12.3 Dietary Reference Intakes for key nutrients for school-age children[55,56]

Age	Recommended Daily Allowances		
	Iron (mg/d)	Zinc (mg/d)	Calcium (mg/d)
4–8 years	10	5	1,000
9–13 years	8	8	1,300

Vitamins and Minerals

DRIs for vitamins and minerals have been established for the school-age and preadolescent child (Table 12.3).[46,47] According to food-consumption surveys, children's mean intakes of most nutrients meet or exceed the recommendations. Still, certain subsets of children do not meet their needs for key nutrients such as iron and zinc, which are important for growth, and calcium, needed to achieve peak bone mass.

12.5 Common Nutrition Problems

During the last century, common nutrition problems have shifted from problems of nutrient deficiencies to problems of excess nutrition, such as energy, fat, and salt. During middle childhood, some children still experience problems such as iron-deficiency anemia and dental caries, especially with easy accessibility to high-sugar foods. These nutrition problems are addressed here, followed by a thorough discussion of prevention of nutrition-related disorders.

Table 12.2 Estimated Energy Requirements (EER) equations by age, sex, physical activity, and energy cost of growth in children and adolescents 3 to 13.99 years

Age Group	Sex	PAL Category	EER Equation (kcal/day)
3 to 13.99 years	M	Inactive	EER = −447.51 + (3.68 × age) + (13.01 × height) + (13.15 × weight) + 20/15/25[a]
		Low active	EER = 19.12 + (3.68 × age) + (8.62 × height) + (20.28 × weight) + 20/15/25
		Active	EER = −388.19 + (3.68 × age) + (12.66 × height) + (20.46 × weight) + 20/15/25
		Very active	EER = −671.75 + (3.68 × age) + (15.38 × height) + (23.25 × weight) + 20/15/25
	F	Inactive	EER = 55.59 − (22.25 × age) + (8.43 × height) + (17.07 × weight) + 15/30[b]
		Low active	EER = −297.54 − (22.25 × age) + (12.77 × height) + (14.73 × weight) + 15/30
		Active	EER = −189.55 − (22.25 × age) + (11.74 × height) + (18.34 × weight) + 15/30
		Very active	EER = −709.59 − (22.25 × age) + (18.22 × height) + (14.25 × weight) + 15/30

NOTES: kcal/d = kilocalories per day; PAL = physical activity level; EER = Estimated Energy Requirement. Age is in years, weight is in kilograms, and height is in centimeters.

[a]Energy cost of growth for boys: 3 y: 20 kcal/d; 4 to 8 y: 15 kcal/d; 9 to 13 y: 25 kcal/d.

[b]Energy cost of growth for girls: 3 y: 15 kcal/d; 4 to 8 y: 15 kcal/d; 9 to 13 y: 30 kcal/d.

Source: National Academies of Sciences, Engineering, and Medicine. *Dietary Reference Intakes for Energy*. Washington, DC: The National Academies Press, 2023. doi: https://doi.org/10.17226/26818.

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Iron Deficiency

Iron deficiency is not as common a problem in middle childhood as it is in the toddler age group. Dietary risk factors for iron deficiency during the school age years include obesity, vegetarian or restrictive diets, especially among children with autism, developmental delay, eating disorder, or in girls who have begun menstruating.[48] The American Academy of Pediatrics (AAP) and CDC both recommend screening for iron-deficiency anemia for children in whom anemia or an iron-deficient diet are suspected, such as those who consume a strict vegetarian diet without taking an iron supplement.[48,49]

Age- and gender-specific cutoff values for anemia are based on the 5th percentile of hemoglobin and hematocrit for age from NHANES III. For children 5 to less than 8 years of age, the diagnosis of anemia is made if the hemoglobin concentration is less than 11.5 g per dL and hematocrit less than 34.5 percent. For children from 8 to less than 12 years of age, a hemoglobin value less than 11.9 g per dL or hematocrit less than 35.4 percent is diagnostic of iron-deficiency anemia.[48,49] Just as in early childhood, the treatment of iron-deficiency anemia in the school-age child consists of an oral iron trial for 4 weeks.[48] In addition, children and their caregivers should be educated on general dietary recommendations for preventing iron-deficiency anemia. These include eating plenty of iron-rich foods, such as meat, fish, poultry, fortified breakfast cereals, and vitamin C-rich foods, such as citrus juice or fruit, which enhance iron absorption.

Dental Caries

Approximately one in two children aged 6–9 years has decay in primary or permanent teeth.[50] Children with poor oral health may also develop periodontal disease. The amount of time that children's teeth are exposed to carbohydrates influences the risk of dental caries or tooth decay. Complex carbohydrates such as fruits, vegetables, and grains are better choices than simple sugars, such as soft drinks or sports drinks and candy, in relation to oral health and nutrition. Sticky carbohydrate-containing foods, such as raisins and gummy candy, are strong caries promoters. Fats and proteins may have a protective effect on enamel. Choosing snacks that are combinations of carbohydrates, proteins, and fats may decrease the risk of developing dental caries. Having regular meal and snack times versus continually snacking throughout the day is also beneficial. Rinsing the mouth after eating—or, better yet, brushing teeth regularly—also decreases the development of caries.[50] It is important that the school-age child continue to have a source of fluoride, either from the water supply or through supplementation. Details about fluoride supplementation were discussed in Chapter 10.

During middle childhood, children lose their primary or baby teeth and begin to get their permanent teeth. If several teeth are missing, children may have trouble in chewing some foods, such as meat. Also, the orthodontic appliances commonly worn by school-age children may interfere with their ability to eat certain foods. Modifying foods, such as by chopping meat or slicing fresh fruit, can help.[1]

12.6 Prevention of Nutrition-Related Disorders in School-Age Children

The prevalence of overweight and obesity among children is at an alarming rate. Recent analysis of dietary data from NHANES indicates significant changes in dietary intake of school-age children over the 20 years from 1989 to 2010.[51] At the same time, decreases in physical activity may be a significant contributing factor to the increased prevalence of overweight.[49] The problem of increasing overweight in the United States needs to be addressed from a public health perspective.[53] Furthermore, children who are overweight are at increased risk for developing risk factors for chronic conditions, such as cardiovascular disease and type 2 diabetes mellitus.[52]

Overweight and Obesity in School-Age Children

Prevalence According to the NHANES 2015–2016 data, a total of 32.8 percent of children ages 6 through 8 years and 35.6 percent of children ages 9 through 11 years are overweight or obese.[54] Because of the continued rise in obesity, and the number of children who are significantly above the 95th percentile of BMI-for-age, researchers and clinicians are now classifying overweight and obesity in four categories. Table 12.4 provides the current classifications of overweight and obesity based on BMI-for-age.

Data from 2015 to 2016 NHANES indicated that 18.8 percent of 6- to 8-year-olds and 18.5 percent of 9- to 11-year-olds were classified with Class I obesity. An additional 5.1 and 1.4 percent of 6- to 8-year-olds, and 5.3 and 1.0 percent of 9- to 11-year-olds were classified with Classes II and III obesity, respectively. In contrast to earlier reports, this analysis does not show a decline in the rates of overweight and obesity in children that has been reported.[54]

However, consistent with past reports there are significant differences in prevalence by race/ethnicity.[54] In 2015–2016, 38.2 percent of Latinx and 35.0 percent of Black children aged 2–19 years were obese (BMI for age percentiles > 95th percentile) as compared with only 19.1 percent of White children and 12.1 percent of Asian American children.[54] Differences based on sex are also evident but are continuing to change. For example, in 2011–2012, 17.9 percent of

Table 12.4 Definition of overweight, Classes I, II, and III obesity[54]

BMI-for-Age and Sex		BMI z-score
Overweight	≥ 85th to 94th percentile	≥ 1.04 SD
Class I obesity	≥ 95th percentile for age	≥ 1.64 SD
Class II obesity	≥ 120% of 95th percentile for age, or BMI ≥ 35 (whichever is lower)	≥ 2.33 SD
Class III obesity	≥ 140% of 95th percentile for age, or BMI ≥ 40 (whichever is lower)	–

SD = Standard Deviation

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Table 12.5 Prevalence of obesity in children 2–19 years of age by sex, race, and obesity class[54]

Race	Class	Girls, %	Boys, %
White	All Classes	18.6	19.7
	Class I	13.6	14.7
	Class II	3.8	4.0
	Class III	1.2	1.0
African American	All Classes	38.2	32.0
	Class I	25.1	19.3
	Class II	9.5	8.6
Hispanic	All Classes	32.4	43.9
	Class I	23.5	28.0
	Class II	6.3	11.9
	Class III	2.6	4.0
Asian American	All Classes	11.3	12.7
	Class I	10.1	11.2
	Class II	1.2	1.5
	Class III	0.0	0.0
Other Non-Asian American	All Classes	28.7	28.5
	Class I	20.9	29.7
	Class II	6.5	8.8
	Class III	1.3	0.0

non-Hispanic White girls were obese, as compared to only 8.8 percent of non-Hispanic White boys.[55] However, in 2015–2016, these numbers had increased and the differences in sex were smaller; 18.6 percent of White girls, aged 2–19 years, and 19.7 percent of White boys are now reported to be obese. Sex differences also appear to be different based on race. While obesity is more prevalent among Black girls than boys (38.2 percent vs. 32.0 percent, respectively), the prevalence of obesity among Latinx boys is much higher than girls (43.9 percent vs. 32.4 percent, respectively). Table 12.5 presents prevalence of obesity by sex, race, and obesity class.[54]

The prevalence of overweight among children has increased steadily over the last 30 years. While reports earlier in the decade seemed to indicate that the prevalence of high BMI appeared to have reached a plateau,[5] the most recent data show that prevalence across all age groups from 2 to 19 years has continued to rise.[54] More recent BMI data for children older than 6 years of age were not included in the current growth charts because of the known increased prevalence of overweight for these ages in NHANES III. Inclusion of this information in the revised growth charts would have reflected a heavier population and would not be a healthy standard. Further analysis shows that the heaviest children are getting heavier. Extreme obesity is increasing in prevalence and has been associated with high risk for cardiovascular disease risk factors.[54,56]

bone age Bone maturation; correlates well with stage of pubertal development.

Characteristics of Children Who Are Overweight

Children who are overweight or obese are usually taller, have advanced **bone ages**, and experience sexual maturity at an earlier age than their non-overweight peers. From a psychosocial standpoint, these children look older than they are, and adults may expect them to behave as if they were older. Health consequences of obesity, such as hyperlipidemia, higher concentrations of liver enzymes, hypertension, and abnormal glucose tolerance, occur with increased frequency in children who are obese than in children of healthy weight.[57] Analysis of data from the Bogalusa Heart Study, a community-based study of adverse risk factors in early life in a biracial population, confirms an increase in chronic disease risk factors with increasing BMI-for-age.[52] Increasing insulin levels, an indication of insulin resistance, show the strongest association with increasing BMI-for-age. Additionally, children are more likely to have more than one chronic disease risk factor, especially those with BMI-for-age percentiles > 99th percentile.[56]

Type 2 diabetes mellitus, previously considered to be a disease of adults, is increasing in children and adolescents in the United States today. Between 2001 and 2017, there was a 95.3 percent increase in type 2 diabetes among children and adolescents aged 10 through 19 years of age,[58] with up to 85 percent of affected children being either overweight or obese at diagnosis.[59] According to the recommendations of a panel of experts in diabetes in children, any child who is overweight and who has other risk factors should be monitored for type 2 diabetes beginning at age 10 or at puberty. Other risk factors include a family history of type 2 diabetes, belonging to certain race and ethnic groups, including Black, Latinx, Asian American, South Pacific Islander, and Native North American, and having signs of insulin resistance.[59]

It is still unclear what effect an early onset of obesity in childhood has on the risk of adult morbidity and mortality.[57] Consequences of obesity and the precursors of adult disease do occur in children who are obese. More studies have been performed on the relationship between obesity during adolescence and the risks of obesity in adulthood than have been performed on the relationship between obesity in childhood and obesity and type 2 diabetes in adulthood (Chapter 15).[60] Although children with a higher BMI are at greater risk for having a higher BMI as an adult, the relationship between high BMI in childhood and risk for illness as an adult is less clear. A systematic review and meta-analysis of 37 studies examining this relationship showed that children with high BMI had higher risk for developing type 2 diabetes, cardiovascular disease, and some types of cancer.[61] However, the accuracy of childhood BMI to predict adult morbidity was low, ranging from only 20 percent for adult cancer, to 22 percent for adult hypertension, and up to 31 percent for adult diabetes.

Predictors of Obesity in Childhood Dietz describes critical periods in childhood for the development of obesity: gestation and early infancy, the period of BMI rebound, and adolescence.[14] BMI rebound is the normal increase in body mass index that occurs after BMI declines and reaches its lowest point, between 5 and 7 years of age, and is reflected

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in the BMI-for-age growth chart.[15] Studies suggest that the age at which BMI rebound occurs may have a significant effect on the amount of body fat that the child will have during adolescence and into adulthood. Early BMI rebound is defined as beginning before 5.5 years of age, while the average age of BMI rebound is 6.0–6.3 years. BMI rebound after age 7 is considered late. Studies have shown that adolescents and adults who had an early BMI rebound as children have higher BMI than those subjects who had an average or late BMI rebound.[15,62] Several possible mechanisms may explain the relationship between BMI rebound and subsequent obesity. The period of BMI rebound may be when children are beginning to express learned behaviors related to food intake and activity. Early BMI rebound may be related to infants who were exposed to gestational diabetes during fetal development and consequently have high birthweights. Although more study is needed, the conclusion is that preventive efforts need to focus on these developmental stages.[14]

Another predictor of obesity during childhood is the child's home environment. Children from birth to 8 years of age were followed over a 6-year period as part of the National Longitudinal Survey of Youth.[63] Associations between the home environment and socioeconomic factors and the development of obesity were examined. Maternal obesity was found to be the most significant predictor of obesity in childhood, followed by low family income and lower cognitive stimulation.

Parental obesity is associated with an increased risk of obesity in children.[64] In one study, parental obesity doubled the risk of adult obesity for both obese and nonobese children less than 10 years of age. An analysis of data from NHANES III indicated a higher percentage of overweight youth among children who had one obese parent as compared to those children who had no obese parents. The percentage of overweight youth increased further if both parents were obese.[65] The connection between obesity among parents and their children is likely due to genetic as well as environmental factors.[64]

Effects of Television Viewing and Screen Time on the Incidence of Overweight One of the Healthy People 2030 objectives is to increase the proportion of parents who follow the AAP guidelines on limiting screen time for children aged 6 to 17 years. Related data analyzed by race and ethnicity, gender, and family income level are depicted in Table 12.6.[6,66] Young children commonly have ready access to handheld devices, tablets, laptops, and smartphones in addition to television. *Screen time* is the term now used to describe the time spent in these sedentary activities, which directly competes with time spent in physical activity. In 2011, the AAP recommended that children have no more than 2 hours each day of screen time and that televisions and other screens be removed from the child's primary sleeping area.[67] However, in recognition of the increased access to and use of media by school-aged children, including required access or devices provided by schools for classwork and homework, they released an updated policy statement in 2016.[68] This statement continues to support the fact that devices should not be permitted in the child's room at bedtime and adds that their use should be discontinued 1 hour before bedtime. Instead of setting a limit of 2 hours per day of screen time, it recommends that families should develop a Family Media Use plan that outlines how much and what type of media use are appropriate for each member of the family.[68] To help families in developing this plan, the AAP has included resources on its Healthy Children website, available at www.healthychildren.org/MediaUsePlan.[69]

Table 12.6 Percentage of children and adolescents viewing television two or fewer hours per day by race/ethnicity, gender, and family income level[66]

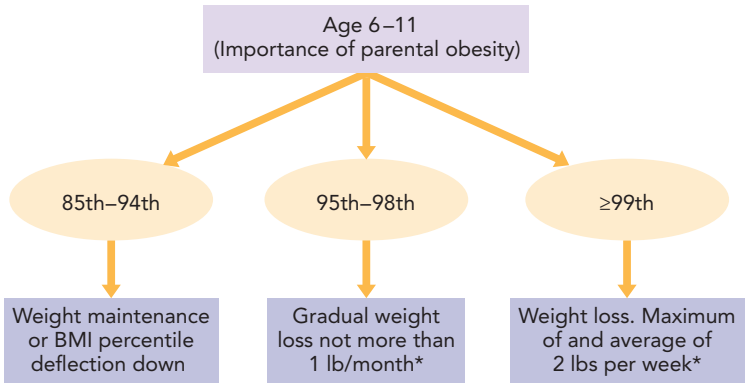
Children and Adolescents Aged 6–14 Years	Television Two or Fewer Hours Per Day, 2007
Race and Ethnicity	
Hispanic or Latino	74.0%
Black or African American	62.9%
White	83.2%
Gender	
Female	80.7%
Male	77.3%
Family Income Level (% Federal Poverty Level)	
<100%	70.1%
100–199%	73.2%
200–399%	80.5%
400%	86.6%

Many studies have demonstrated the strong relationship between TV viewing and obesity in childhood, including studies that have followed subjects longitudinally from childhood to adulthood.[67] Although the AAP had previously recommended no more than 2 hours per day of screen time, a recent study found that children 4 through 9 years of age were at higher risk for obesity if they viewed more than 1.5 hours of TV per day.[70] In these same children, computer use did not increase their risk of obesity. The proposed mechanisms by which television viewing contributes to obesity include reduced energy expenditure by displacing physical activity, increased dietary intake by eating during viewing or as a result of food advertising, and disruption of healthy sleep patterns.[67] One study found that energy expenditure during television viewing was actually significantly lower than **resting energy expenditure** in 15 children who were obese and 16 children with healthy weight who ranged in age from 8 to 12 years.[71] Other studies have found a direct relationship

resting energy expenditure The amount of energy needed by the body in a state of rest.

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between screen time in children aged 9–16 years and their intake of junk foods, including sweet and salty snacks and sugar-sweetened drinks, as well as total calories.[72] At the same time, intakes of fruits and vegetables were inversely related to screen time, meaning there were fewer of these healthier choices consumed as screen time increased. Based on these findings, it is hypothesized that screen time, and especially television viewing, does contribute to the prevalence of obesity, and that treatment for obesity in childhood should include a reduction in the number of hours spent watching television and videos and playing video and computer games. Table 12.6 shows the relationship of TV viewing to race/ethnicity, gender and family income level in 6 to 14-year-olds.



*Excessive weight loss should be evaluated for high risk behaviors

Figure 12.3 Suggested weight changes in staged treatment of pediatric obesity.

Source: Based on data from B. A. Spear, et al. Recommendations for treatment of child and adolescent overweight and obesity. *Pediatrics*. 120 (2007): S254–S288.

Addressing the Problem of Overweight and Obesity in Children

"An ounce of prevention is worth a pound of cure."

—Proverb

Recognizing the increase in the prevalence of childhood overweight and its associated chronic health problems, the AAP, AND, and eight other professional organizations joined together to develop a series of recommendations.[10,11,73,74] The expert committee's evidence-based recommendations address the topics of assessment, prevention, and treatment of pediatric obesity.

Assessment of Overweight and Obesity Body mass index-for-age percentile is recommended as the screening tool for assessment of pediatric overweight and obesity. A BMI-for-age percentile of greater than or equal to the 85th but less than or equal to the 94th is defined as overweight, and a BMI-for-age percentile greater than or equal to the 95th is defined as obesity.[10,11] In keeping with the recommendation of using *z*-scores to evaluate children's nutritional status, the Academy of Nutrition and Dietetics recently published the corresponding BMI *z*-scores (Table 12.4).[75] Other components of assessment include evaluation of the child's medical risk, including parental obesity, and behavior risk, including dietary and physical activity behaviors. It is also essential to evaluate the child's and/or family's attitude toward and willingness to make behavior changes.[10,11]

Prevention of Overweight and Obesity All children should be targeted for prevention of overweight and obesity throughout their lives. The expert committee's recommendations for targeted behaviors in overweight and obesity prevention are described in detail in Chapter 10.[74]

Treatment of Overweight and Obesity The expert committee's recommendations for a four-stage approach to treatment of overweight and obesity in pediatrics are described in detail in Chapter 10.[10,73] Figure 12.3 depicts suggested weight changes for 6- to 11-year-old children during treatment of overweight and obesity.[10,73] The four stages include:

- Stage 1: Prevention Plus
- Stage 2: Structured Weight Management (SWM)
- Stage 3: Comprehensive Multidisciplinary Intervention (CMI)
- Stage 4: Tertiary Care Intervention (reserved for severely obese adolescents)

The overall goal of treatment is for the child and family to develop healthy eating and physical activity behaviors for a lifetime. For children who fall into the overweight category based on a BMI-for-age between the 85th and 94th percentiles, the goal of treatment should be weight maintenance or a slowing of the rate of weight gain until a BMI-for-age $<$ 85th percentile is achieved. For children with BMI-for-age of 95th–98th percentiles, weight maintenance or gradual weight loss of no more than 1 lb per week is the goal until the BMI-for-age drops to $<$ 85th percentile. Weight loss not to exceed 2 lb per week is the goal of treatment for those children with BMI-for-age $\geq$ 99th percentiles until a BMI-for-age $<$ 85th percentile is achieved.[10,73] (Refer to Case Study 12.1.)

The Academy of Nutrition and Dietetics most recent position paper on treatment of pediatric overweight and obesity recommends a multicomponent approach to treatment.[75] They emphasize the importance of the program being culturally relevant for the participants and their families, who should be involve in treatment along with their children. Key aspects of treatment include a diet approach under the guidance of a registered dietitian nutritionist (RDN), screening for mental health issues, use of inclusive language, and consideration for the use of emerging technologies including electronic devices or telehealth.

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Case Study 12.1 Overweight

Seven-year-old Tyler's mother takes him to his pediatrician for his annual checkup. His weight is 68 lb (31 kg), plotted at the 95th percentile, and his height is 50 in. (127 cm), between the 75th and 90th percentiles for his age. His body mass index of 19.25 kg/m^2 plots at the 95th percentile for his age. His growth percentiles have been increasing over the last several years.

Tyler's mother expresses concern to the pediatrician about her son's weight. His older and younger brothers are both thinner than Tyler. Tyler's mother has obesity, but his father does not. Tyler is in the second grade. He rides the school bus to and from school. He participates in the school lunch program at his school, and his parents gave him extra money in case he wants to buy additional food from the cafeteria or vending machine. After school, Tyler and his brothers stay in their home with a babysitter until a parent returns home from work. Tyler usually watches videos and plays video games after school. His parents leave snack foods—chips, cookies, and sodas—in the house for their sons to have after school. His parents prepare an evening meal consisting of a meat, starch, vegetables, and a dessert item. After dinner, Tyler does his homework and watches more TV with his parents. He usually has a dish of ice cream before going to bed.

Questions

1. What is your assessment of Tyler's body size based on his weight-for-age, height-for-age, and BMI-for-age percentiles?
2. What suggestions do you have for Tyler's parents about improving his eating habits?
3. What suggestions do you have for Tyler's parents for increasing his physical activity level?
4. Is it significant that Tyler's mother also has obesity?



Photodisc

Some potential consequences of a weight-loss program in childhood are a slowing of linear growth and the beginnings of eating disorders. To reduce the risks associated with weight loss in childhood, the program must ensure nutritional adequacy of the diet, a nonjudgmental approach, and attention to the child's emotional state.[10,73]

Nutrition and Prevention of Cardiovascular Disease in School-Age Children

The American Heart Association (AHA) and the AAP have jointly issued guidelines for cardiovascular health promotion in all children and adolescents, including dietary recommendations.[76] The recommended diet is consistent with the Dietary Guidelines for Americans, MyPlate, and the DRIs, including a recommended total fat intake of 25–35 percent of total calories.[41] Emphasis is placed on adequate intakes of omega-3 fatty acids, with a recommendation of at least two servings of fish each week. Table 12.7 illustrates the adequate intake of linoleic acid and alpha-linolenic acid for children 4 to 13 years of age. Limiting the intake of fruit juice, sugar-sweetened beverages and foods, and salt is also recommended. For children over 2 years of age, these guidelines recommend limiting foods high in saturated fats (<7 percent of total calories per day), cholesterol (<300 mg per day), and *trans* fatty acids (<1 percent of total calories per day).[76,77,78]

As discussed in Chapter 10, the National Heart, Lung, and Blood Institute (NHLBI) convened a panel of experts to develop evidence-based cardiovascular health guidelines for pediatric care providers.[79] This panel recommends universal lipid screening between the ages of 9 and 11 years, as this age has been determined to be a stable time for lipid assessment. The panel recommends a Cardiovascular Health Integrated Lifestyle Diet (CHILD-1) for children with risk

Table 12.7 Adequate intake of linoleic acid and alpha-linolenic acid[53]*

Gender and Age	Linoleic Acid (g/day)	Alpha-Linolenic Acid (g/day)
Children 4–8 years	10	0.9
Boys 9–13 years	12	1.2
Girls 9–13 years	10	1.0

*Refer to Chapter 1 for a list of food sources.

Source: Based on data from The Institute of Medicine, Food & Nutrition Board. Dietary Reference Intakes for energy, carbohydrate, fiber, fat, protein, and amino acids. Washington, D.C.: National Academy Press, 2002/2005.

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factors such as overweight and obesity as well as for children with a positive family history of early cardiovascular disease or risk factors such as obesity or primary hypertension. Children with hyperlipidemias require further dietary restrictions to help control LDL cholesterol (CHILD-2-LDL diet) and/or triglycerides (CHILD-2-TG). Further restriction of dietary cholesterol to 200 mg per day and avoiding *trans* fatty acids as much as possible are recommended.[79] Refer to Table 10.8 for more information about the CHILD-1, CHILD-2-LDL, and CHILD-2-TG evidenced-based recommendations. Increasing soluble fiber intake, emphasizing weight management and physical activity, and follow-up by a registered dietitian are also treatment recommendations.[79] Employing behavior change theory and motivational interviewing may be useful strategies when counseling children and families on these dietary recommendations.[79]

Dietary Supplements

Children who are healthy and consume a diet of a variety of foods do not require a vitamin and mineral supplement to meet their nutrient needs. The AAP recommends vitamin and mineral supplementation for children who are at high risk of developing nutrient deficiencies or have one or more documented nutrition deficiency.[48] These deficiencies include:

1. Anorexia or an inadequate appetite
2. Who follow fad diets or diets high in fat
3. With chronic disease, especially gastrointestinal of malabsorptive disease
4. From deprived families or who suffer from parental neglect or abuse
5. Who participate in a dietary program for managing obesity
6. Who consume a vegetarian diet without adequate intake of dairy products
7. Who are receiving chemotherapeutic, antituberculosis or anticonvulsant medications.

If vitamin and mineral supplements are given to school-age children, the supplement should not exceed the DRI for age. Parents should be warned against giving amounts of vitamins and minerals that exceed the Tolerable Upper Intake levels designated in the DRI tables.[46,47]

It is not clear to what extent herbal supplements are given to school-age children. Herbal supplements are used in some cultures as home remedies. A report of complementary and alternative medicine (CAM) use in U.S. children aged 4–11 years showed that about 9.5 percent of the population had used some form of CAM in the 12 months prior to the survey.[80] The most used type of CAM was nonvitamin, nonmineral dietary supplements, including fish oil, melatonin, probiotics or prebiotics, and echinacea. It is important to obtain this information from parents and caretakers as part of the child's health history. The use of herbal supplements, botanicals, and vitamin/mineral supplements may be a more prevalent practice by parents of children with special health-care needs.

total fiber Sum of dietary fiber and functional fiber.

dietary fiber Complex carbohydrates and lignins naturally occurring and found mainly in the plant cell wall. Dietary fiber cannot be broken down by human digestive enzymes.

functional fiber Nondigestible carbohydrates including plant, animal, or commercially produced sources that have beneficial effects in humans.

12.7 Dietary Recommendations

The basic dietary recommendation for school-age and preadolescent children is to eat a diet of a variety of foods, which is why it remains so important throughout these school years for children to have a variety of foods available to them. The available food environment will affect children's food choices. Parents and other adult role models need to continue to model appropriate eating behaviors for children.

Dietary recommendations, as outlined by the USDA in the Dietary Guidelines for Americans and MyPlate, apply to school-age children as well as to other segments of the population.[22,32] Professional organizations, such as the AHA, the AAP, and the AND, have also published positions on dietary guidance for healthy children, supporting the federal guidelines.

Recommendations for Intake of Iron, Fiber, Fat, Calcium, Vitamin D, and Fluids Adequate iron nutrition is still important during middle childhood and preadolescence to prevent iron-deficiency anemia and its consequences. According to food-consumption surveys, children are not eating the recommended amounts of fiber in their diets, but they are exceeding the recommendations of total calories from fat and saturated fat. Calcium requirements increase during the preadolescent years, but calcium intake decreases with age.

Iron Although iron deficiency is not as prevalent during the school-age years as it was during the toddler and preschool-age years, adequate intake of iron is still important. The inclusion of iron-rich foods—such as meats, fortified breakfast cereals, and dry beans and peas—in children's diets is important. A good vitamin C source, such as orange juice, consumed at the same time as iron-containing foods will enhance the absorption of iron.

Fiber Many health effects of fiber intake have been identified—including prevention of chronic disease in adulthood, such as heart disease, certain cancers, diabetes, and hypertension. The recommendations for **total fiber** intake based on the DRIs can be found in Table 12.8. Total fiber is the sum of **dietary fiber** and **functional**

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Table 12.8 Adequate intake of total fiber[53]

Gender and Age	Total Fiber (g/day)
Children 4–8 years	25
Boys 9–13 years	31
Girls 9–13 years	26

Source: From the Institute of Medicine, Food & Nutrition Board.

fiber. Although there is little research on the effect of fiber intake during childhood on health as an adult, there is agreement that the fiber intake of children is generally too low.[81]

To increase the dietary fiber in children's diets, parents and caretakers can begin by increasing the amount of fresh fruits and vegetables, and whole-grain breads and cereals being offered. High-fiber fruits, such as apples with peels, have about 3 g per serving, while fruit juices are low in fiber. High-fiber vegetables, such as broccoli, have about 2.5 g per serving. Whole-grain breads, cereals, and brown rice have about 2.5 g per serving. High-fiber cereals, such as bran flakes and raisin bran, have about 8–10 g per serving. Served alone, these high-fiber cereals may not be well accepted by young children, but they can be mixed with other cereals or used in recipes for food items such as muffins. Dried beans and peas are also excellent sources of fiber, providing 4–7 g of fiber per ½-cup serving.[82]

Fat Food intakes that follow the recommendations of the Dietary Guidelines for Americans and MyPlate provide an appropriate amount of fat for school-age and preadolescent children.[22,32] Healthy diets include whole-grain breads and cereals; beans and peas; fruits and vegetables; low-fat dairy products; and lean meats, fish, and poultry. Foods high in fat, especially those high in saturated fat and *trans* fatty acids, should be kept to a minimum. However, an appropriate amount of dietary fat is necessary to meet children's needs for calories, essential fatty acids, and fat-soluble vitamins.

Calcium and Vitamin D The recommendations for adequate daily intakes of calcium are 1,000 mg for children aged 4–8 years and 1,300 milligrams for children 9 through 13 years.[46] The higher recommendation for older children reflects the fact that most bone formation occurs during puberty. Adequate calcium intake during this time is necessary to achieve peak bone mass, which may prevent osteoporosis later in life.[83]

Good sources of calcium are listed in Chapter 1. It is difficult to meet the higher recommendations of calcium without the inclusion of dairy products, preferably low-fat dairy products. One cup of skim or low-fat milk contains about 300 mg calcium. Calcium-fortified foods such as fruit juice and soy milk are also available for children such as those on a vegan diet.

Adequate vitamin D is needed for calcium absorption. The revised DRIs for calcium and vitamin D set the Recommended Dietary Allowance (RDA), a value that meets the needs of most people, at 600 Ius per day for children 4–18 years of age.[46] Main sources of vitamin D include exposure to sunlight, vitamin D–fortified foods such as fortified cereals, and vitamin D–fortified milk (100 IU per 8 oz).[83] Children who are at risk for vitamin D deficiency include those with increased skin pigmentation, including African Americans and Hispanics, and those with limited sunlight exposure. For children whose calcium and vitamin D intakes are inadequate or who are at increased risk for vitamin D deficiency, supplements need to be given under the guidance of a physician or registered dietitian.

Lactose Intolerance Lactose intolerance, more commonly seen in older children than in younger children, is a common cause of abdominal pain. Lactose intolerance is a clinical syndrome of one or more gastrointestinal symptoms (e.g., abdominal pain, diarrhea, nausea, flatulence, or bloating) after consumption of lactose or lactose-containing foods or beverages. Lactose malabsorption, the disorder that manifests itself as lactose intolerance, is caused by reduced digestion of lactose because of the low availability of the enzyme lactase. Lactase breaks down lactose, the disaccharide in milk and milk products.[84]

Lactose intolerance can be caused by a primary lactase deficiency, which is the relative or absolute absence of the enzyme. Primary lactase deficiency is especially common in certain racial and ethnic groups, including Latinx (50–80 percent), Black and Ashkenazi Jewish (60–80 percent), and Asian Americans and Native North American people (nearly 100 percent).[84] Affected individuals have varying degrees of lactose intolerance, and dairy products should be included in their diets as individually tolerated. Lactose-containing foods in small amounts, spaced throughout the day, and eaten with other foods may be tolerated by many people with lactose intolerance. Additionally, yogurts, cheeses, and lactose-reduced dairy products have lower lactose content and may be well tolerated.

Secondary lactase deficiency can be caused by injury to the small bowel, such as from an acute infection. The underlying condition should be treated, and often the elimination of lactose from the diet is not necessary at all, but milk products should definitely be resumed once the underlying condition has resolved. The concern with both primary and secondary lactase deficiency is to avoid the total elimination of dairy products from the diet when it may not be necessary, as these foods are important sources of calcium, vitamin D, and other nutrients.[84]

Fluids School-age children need to drink enough fluids to maintain adequate hydration especially during periods of physical activity. Adults who are supervising children's

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physical activities need to make sure that children drink fluids before, during, and after exercise. The thirst mechanism may not work as well during exercise, and children may not realize that they need fluids. Cold water is the best fluid for children, and they should have free access to water, particularly during school hours.[85] Sports drinks, which contain 4–8 percent carbohydrate and diluted fruit juice, are most appropriate for children who are participating in prolonged vigorous physical activity, especially in hot and humid climates.[85] Some sports, such as football and hockey, require special protective gear that may prevent the body from being able to cool off. Children should never deprive themselves of food or water to meet a certain weight category, such as in wrestling. Children should not be given soft drinks or undiluted juice because the carbohydrate load is too high to be hydrating and could cause stomach cramps, nausea, and diarrhea.[86] Energy drinks should not be consumed by children because they contain high amounts of caffeine and other stimulant substances, such as guarana, a plant extract that contains caffeine. Inappropriate use of sports drinks and energy drinks can contribute a significant amount of calories from carbohydrate to a child's diet and possibly contribute to excessive energy intake.[87]

Soft Drinks School-age children consume more soft drinks than preschool-age children do, but not as much as adolescents—indicating an increase in consumption with age. Children with high consumption of regular soft drinks (more than 9 oz per day) consume less milk and fruit juice than do those with lower consumptions of regular soft drinks. A study of 548 ethnically diverse school-age children, with an average age 11.7 years, showed that BMI and the frequency of high BMI greater than 95th percentile increased along with increased consumption of sugar-sweetened beverages (SSBs).[87]

While children's consumption of all SSBs increased from 1988 to 2004,[88] a more recent analysis of the top-10 food and beverage sources of energy for children aged 2–18 years shows that the peak intake of SSB may have been in 2003–2004, with a steady decline in intake since then.[61] In fact, between 2003 and 2016, calories from SSB decreased among children aged 2 to 19 years by approximately 60 percent.[89]

Soft drinks can contribute significantly to children's overall calorie and caffeine intake while contributing little to the overall nutritional value of their diets and displacing more nutritious foods. According to USDA food-consumption data, children's soft-drink consumption increases with age while milk consumption decreases at a time when calcium requirements are increasing.[46,90] Children who ate fast food consumed more carbonated nondiet beverages and less milk than children who did not eat fast food.[91] Diet soft drinks do not provide sugar, and the aspartame content of diet sodas does not appear to pose a risk to healthy children.[92] Soft drinks in excess are not recommended for school-age children because they provide empty calories, promote tooth decay, and are not a good fluid choice for hydration.

Recommended Versus Actual Food Intake

A measure of diet quality is provided by the Healthy Eating Index (HEI; available at www.usda.gov/cnpp), which utilizes data from the ongoing NHANES.[93] The HEI measures the degree to which an individual's diet conforms to the Dietary Guidelines for Americans and uses the food-group standards found in MyPlate.[22,32] The index also measures total and saturated fat intake, cholesterol intake, sodium intake, and variety. According to the 2020–2025 Dietary Guidelines, the HEI for children 5 to 8 years of age is 55, and for children 9 to 13 years of age is 52[32] (Figures 12.4 and 12.5). These values are slightly lower than HEI scores of children aged 2–4 years (HEI = 61) and slightly higher than HEI scores of older teenagers (HEI = 51), indicating that these years reflect a transition from parent-selected to child-selected food choices.

Cross-Cultural Considerations

One of the overarching goals of Healthy People 2030 is to "eliminate health disparities, achieve health equity, and attain health literacy to improve health and well-being of all."[6]

The reasons for the health disparities are complex but may include genetic variations, environmental factors, and health behaviors, including diet. Access to community-based, culturally competent, linguistically appropriate preventive health care is needed to eliminate these disparities.

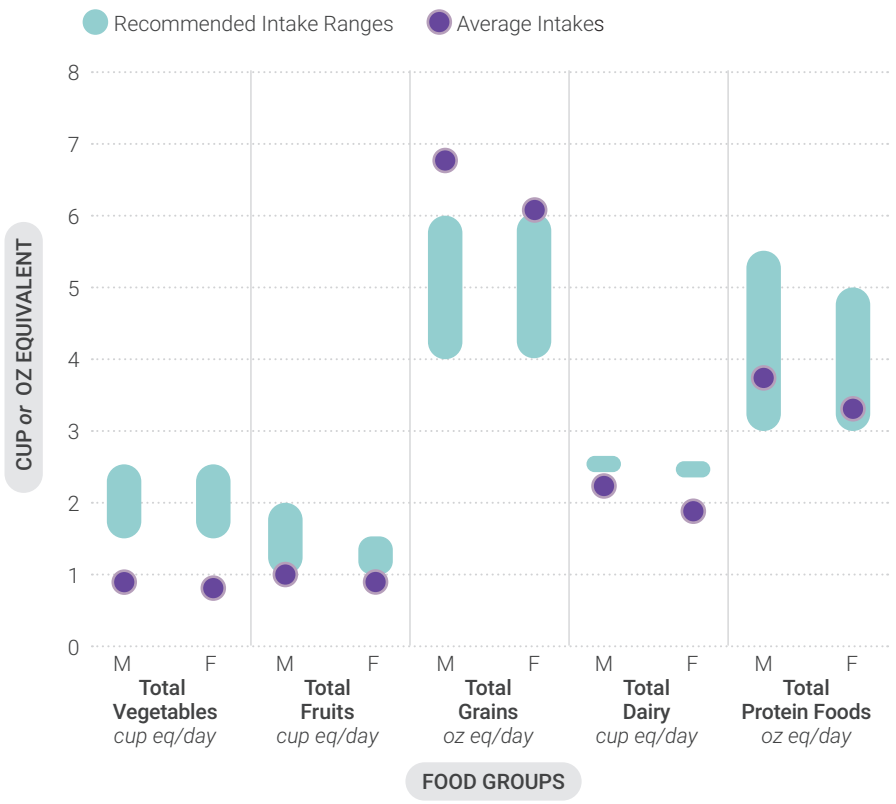
A unique characteristic of every cultural group in America is foods and food habits.[94] As discussed earlier, children learn food habits within the context of their family's culture. It is important for a health-care professional to try to learn as much as possible about the foods and diets of the cultural groups served, including where food is purchased and how it is prepared.[1]

The next step is to evaluate the diet within the context of the culture. Which foods or food habits have positive health benefits and should be encouraged? Which food behaviors have harmful effects on health and should be limited or modified? For example, in working with the Latinx population, it is important to first establish the country of origin. Latinx immigrants may be from Mexico, Central America, South America, or the Caribbean. Food habits are unique for each of these groups and eating habits may vary. For example, Central American people may eat a lot of legumes, rice, and corn. Fruits and vegetables are also included in the diet. These dietary practices form the basis of a healthy diet. In contrast, White Americans consume diets high in refined carbohydrates which may contribute to unstable blood sugar and higher risk for excessive weight gain.

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Current Intakes: Ages 5 Through 8

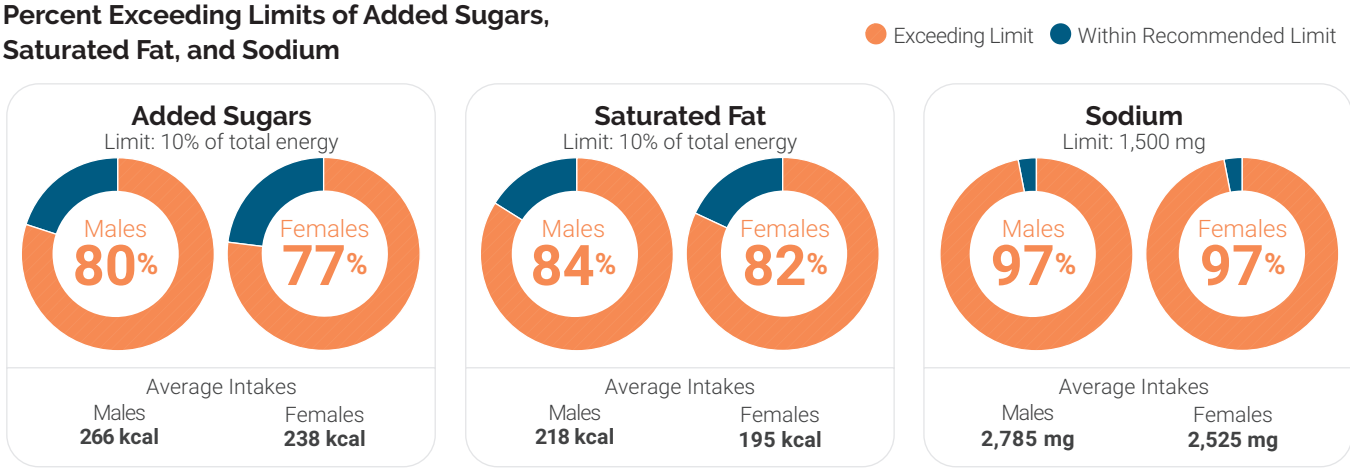
Average Daily Food Group Intakes Compared to Recommended Intake Ranges



Healthy Eating Index Score (on a scale of 0-100)



Percent Exceeding Limits of Added Sugars, Saturated Fat, and Sodium



Data Sources: *Average Intakes and HEI-2015 Scores:* Analysis of What We Eat in America, NHANES 2015-2016, day 1 dietary intake data, weighted. Recommended Intake Ranges: Healthy U.S.-Style Dietary Patterns (see ***Appendix 3***). *Percent Exceeding Limits:* What We Eat in America, NHANES 2013-2016, 2 days dietary intake data, weighted.

Figure 12.4 Current daily food group intake, Healthy Eating Index Score and percent exceeding limits for 5– through 8-year-old children.

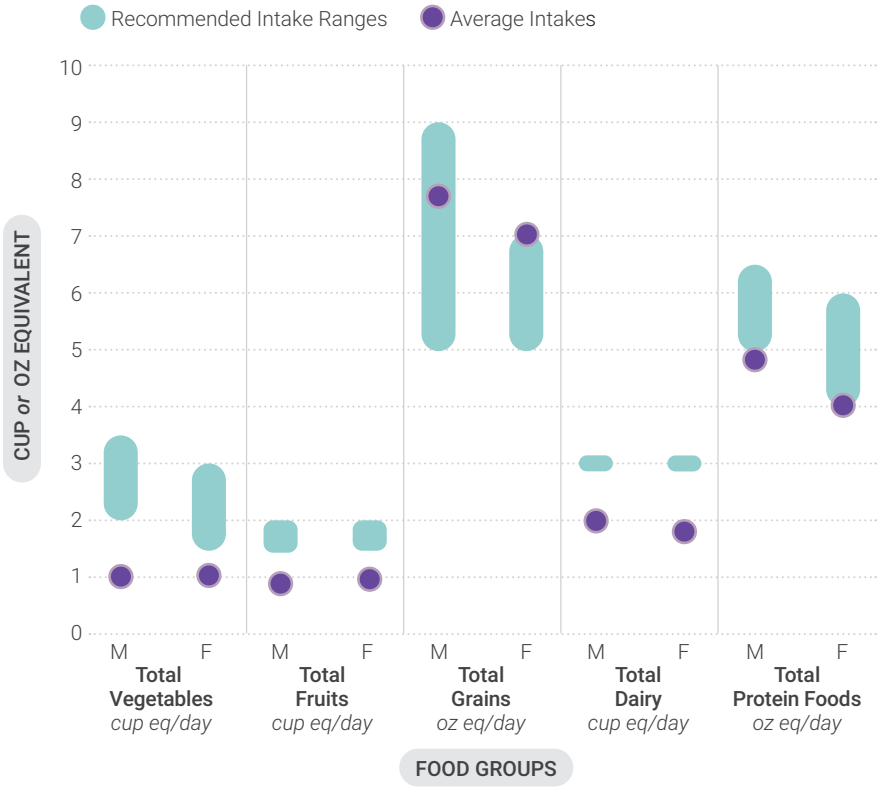
Vegetarian Diets

Young children who are consuming vegetarian diets are usually following their parents' eating practices. Preadolescents, on the other hand, may choose to follow a vegetarian diet independently of the family, motivated by concerns about animal welfare, ecology, and the environment.[1] On the one hand, children following vegetarian and vegan diets can achieve growth comparable to the total population, but may

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Current Intakes: Ages 9 Through 13

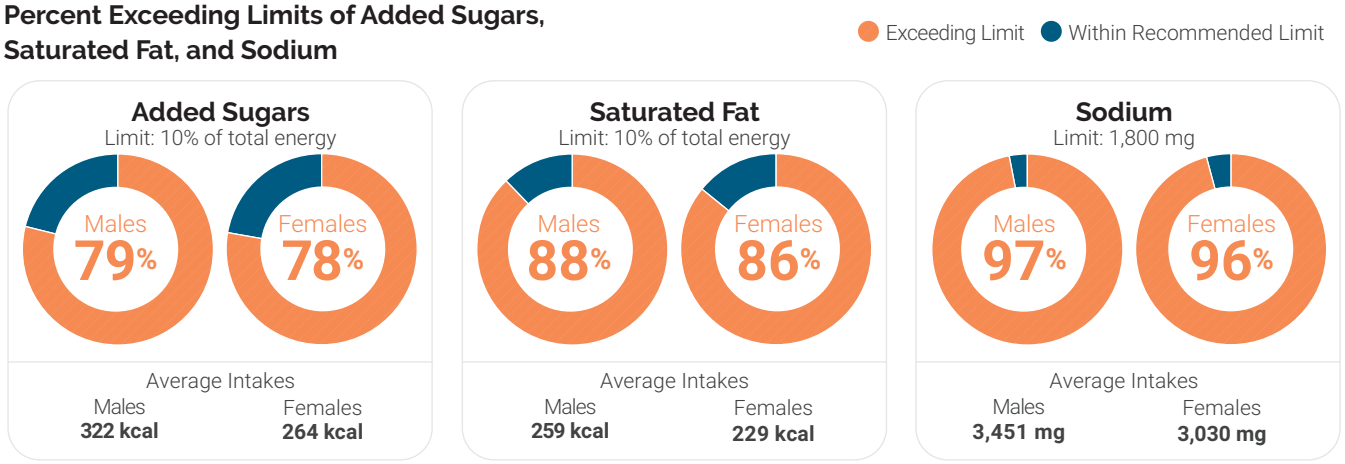
Average Daily Food Group Intakes Compared to Recommended Intake Ranges



Healthy Eating Index Score (on a scale of 0-100)



Percent Exceeding Limits of Added Sugars, Saturated Fat, and Sodium



Data Sources: *Average Intake and HEI-2015 Scores:* Analysis of What We Eat in America, NHANES 2015-2016, day 1 dietary intake data, weighted. *Recommended Intake Ranges:* Healthy U.S.-Style Dietary Patterns (see ***Appendix 3***). *Percent Exceeding Limits:* What We Eat in America, NHANES 2013-2016, 2 days dietary intake data, weighted.

Figure 12.5 Current daily food group intake, Healthy Eating Index Score and percent exceeding limits for 9- through 13-year-old children.

be at higher risk for some nutrient deficiencies.[95] On the other hand, these children have a lower risk of becoming obese and better chance of meeting the dietary guidelines. Health-care providers working with children following a vegetarian diet should pay special intake to their intakes of protein, essential fatty acids, calcium, iron, zinc, vitamin B_{12}, and vitamin C.[96]

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12.8 Physical Activity Recommendations

Physical activity has many proven health benefits, including prevention of chronic diseases such as coronary heart disease, increasing insulin sensitivity, building muscle strength, and controlling energy balance. Physical activity is one health behavior that is important to establish in childhood as part of a healthy lifestyle that will continue into adolescence and adulthood. With the increased prevalence of childhood obesity, increasing physical activity and decreasing sedentary behaviors become important factors in controlling childhood overweight.[97]

Recommendations Versus Actual Activity

It is recommended that children engage in at least 60 minutes of physical activity every day (Photo 12.3).[97]

Strategies for parents include the following:

- Set a good example by being physically active themselves and joining their children in physical activity.
- Encourage children to be physically active at home, at school, and with friends.
- Limit television and video watching, computer and video game playing, time at the computer, texting, and other inactive forms of play by alternating with periods of physical activity.

As has already been mentioned, it is recommended that screen time for children be limited to not more than 2 hours per day, which is a Healthy People 2030 objective.[6] Televisions and other media, such as computers and smartphones, should be removed from children's bedrooms.[68] Additionally, physical activity and daily physical education should be encouraged at schools and during after-school care programs. Community-based sports and recreational activities for children are also encouraged, as well as using school-based facilities outside of school hours to give community access to appropriate locations for safe physical activity.

The AAP has recommended that schools reinstate daily physical education (PE) classes for all grade levels, to promote development of knowledge, skills, and attitudes to support a physically active lifestyle.[97] The CDC advocates development of a Comprehensive School Physical Activity Program (CSPAP).[98,99] Refer to Figure 12.6. The goals



Amanda Mills/Center for Disease Control and Prevention

Photo 12.3 A comprehensive school physical activity plan is recommended to support adequate physical activity.

of this program are to provide a variety of school-based physical activities to enable all students to participate in 60 minutes of moderate-to-vigorous physical activity each day and to provide coordination among the CSPAP components to maximize understanding, application, and practice of the knowledge and skills learned in physical education so that all students will be fully physically educated and well-equipped for a lifetime of physical activity.[99]

In order to meet these goals, communities need to ensure that there are safe places for children to walk and ride their bicycles. The "built environment" is the term used to describe the overall structure of the physical environment of a child's community.[100,101] The physical environment can

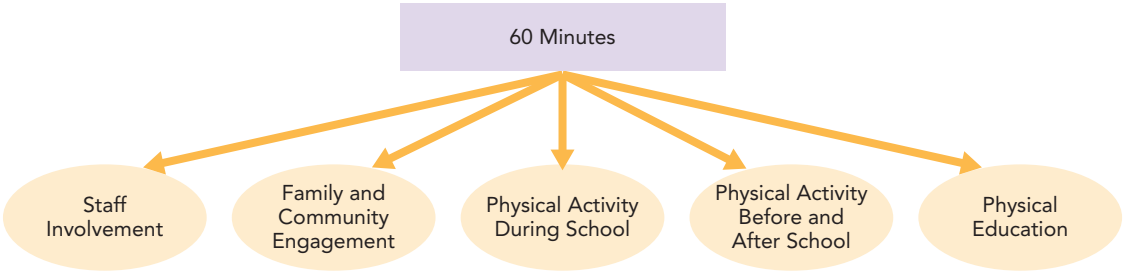


Figure 12.6 Suggested components of a Comprehensive School Physical Activity Program.[99]

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be conducive to a healthy lifestyle by providing safe places such as parks for children to play in, sidewalks for walking to school, or bike paths (Photo 12.4). Or the physical environment can be a barrier to a healthy lifestyle. In addition to the distances children must walk to school, parents are also concerned about traffic danger, followed by concerns about crime and weather.

Communities can also offer youth sports and recreation programs that are developmentally appropriate and fun for all young people. To achieve such a community environment, partnerships need to be established among federal, state, and local governments, nongovernmental organizations, and private entities.

Determinants of Physical Activity

Determinants of physical activity behaviors among children include physiological, environmental, psychological, social, and demographic factors.[102] Additional factors that may limit childhood physical activity include feelings of safety, belonging, and inclusion.[103] Childhood physical activity has been difficult to assess and to track into adulthood. Many of the studies have identified correlates of physical activity behavior rather than predictors. The determinants of childhood physical activity are probably multidimensional and interrelated. More work needs to be done in this area, but some generalities resulting from existing studies are:

- Girls are less active than boys.
- Physical activity decreases with age.
- Children with obesity are less active than children without obesity.[102]
- Seasonal and climate differences are seen in children's activity levels.
- Physical education in schools has decreased.

School and neighborhood safety is an important issue in promoting physical activity. In addition, parents have direct and indirect effects on children's physical activity levels.

Organized Sports

Many school-age and preadolescent children participate in organized sport activities, through schools or other community organizations. An analysis of NHANES III data indicates that children who participate in team sports and exercise programs are less likely to be overweight compared to nonparticipants (Photo 12.5).[65] The AAP



Amanda Mills/Center for Disease Control and Prevention

Photo 12.4 The physical environment can promote a healthy lifestyle by providing safe places for children to play and sidewalks for walking to school.



Beth Leonberg

Photo 12.5 Children who participate in organized sports are less likely to be overweight.

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recognizes the fact that organized sports for children have become widely accepted in our society and provide opportunities for physical activity for children. The AAP recommends that children be involved in sports that are appropriate for their physical and cognitive development.[104] Emphasis should be placed on having fun and on family participation rather than on being competitive. Organized sports should not take the place of regular physical activity, such as physical education in school and free play.[104] The proper use of safety equipment, such as helmets, pads, mouth guards, and goggles, should be encouraged. The AAP warns against intensive, specialized training for children. Coaches should be educated about developmental and safety issues.[104] Recommendations for sports participation by children stress the importance of proper hydration. The AAP encourages the use of water for hydration in most instances, with carbohydrate and electrolyte-containing sports drinks being used only when a child is involved in vigorous or prolonged physical activity.[105] In spite of being heavily marketed at children and especially adolescents, the AAP has warned against the use of energy drinks in children because many of their ingredients, including added sugars, caffeine, and substances such as guarana, have known or potential harmful effects on children.[105]

12.9 Nutrition Intervention for Risk Reduction

"It is the position of the Academy of Nutrition and Dietetics, School Nutrition Association, and Society for Nutrition Education and Behavior, that comprehensive, integrated nutrition programs in preschool through high school are essential to improve the health, nutritional status, and academic performance of our nation's children."[106]

—The Academy of Nutrition and Dietetics

School Wellness Policies

Eating a healthy diet and participating in physical activity are important components of a healthy lifestyle that may prevent chronic disease in childhood and into adolescence and adulthood. As of 2007, all school districts that participate in the National School Lunch Program (NSLP) are required to develop a school wellness policy. The Healthy, Hunger-Free Kids Act of 2010 further strengthened these requirements (Table 12.9).[107]

Nutrition Education and Promotion

School age is a prime time for learning about healthy lifestyles and incorporating them into daily behaviors. Schools can provide an appropriate environment for nutrition education and learning healthy lifestyle behaviors. It has been reported that an average of 13 hours per year is spent in elementary school classrooms teaching lessons about nutrition; however, research demonstrates that 50 hours are required to facilitate behavior change.[107] Nutrition education includes not only direct education taught in the classroom, but also all other ways that healthy eating and habits can be encouraged throughout the school environment. To be effective, nutrition education in schools needs to target specific behaviors, engage and motivate students taking into consideration cultural diversity, and use active methods including technology and hands-on growing and preparing food.[107]

Table 12.9 Local school wellness policy requirements[107]

At a minimum, a local school wellness policy must:

- Include goals for nutrition promotion and education, physical activity, and other school-based activities that promote student wellness.
- Include nutrition guidelines to promote student health and reduce childhood obesity for all foods available in each school district.
- Permit parents, students, representatives of the school food authority, teachers of physical education, school health professionals, the school board, school administrators, and the general public to participate in the development, implementation, and review and update of the local wellness policy.
- Inform and update the public (including parents, students, and others in the community) about the content and implementation of local wellness policies.
- Be measured periodically on the extent to which schools are in compliance with the local wellness policy, the extent to which the local education agency's local wellness policy compares to model local school wellness policies, and the progress made in attaining the goals of the local wellness policy, and make this assessment available to the public.

Competitive Foods and Food Marketing

There are many challenges to nutrition integrity in schools. Foods sold from vending machines and snack bars often do not support healthy eating and may undermine sound nutrition programs. Historically, vending machine proceeds have been an important source of revenue for some schools. Schools may have **pouring rights** contracts with soft-drink companies and receive a percentage of the profits.[107] Many schools also sell à la carte items in addition to standard school lunches to increase revenue. One study of children in first through twelfth grade showed that

pouring rights Contracts between schools and soft-drink companies, whereby the schools receive a percentage of the profits of soft-drink sales in exchange for the school offering only that soft-drink company's products on the school campus.

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40 percent of children consumed at least one **competitive food** on a usual school day.[108] The competitive foods chosen were energy-dense and had few nutrients. Interestingly, children who ate a school lunch were significantly less likely to eat competitive foods.

In 2004, the AAP Committee on School Health has issued a policy statement about nutrition concerns regarding soft-drink consumption in schools.[109] It advocates for the elimination of sweetened beverages in schools and their replacement with beverages such as real fruit and vegetable juices, water, and low-fat white or flavored milk. It discourages vended food or drink contracts, and stated that the health and nutritional interests of students should form the foundation of nutritional policies in schools. Because of the ongoing concern for the availability of competitive foods in the school environment, the AAP Council on School Health and Committee on Nutrition jointly issued a policy statement in 2015, urging continued efforts for improvement.[110]

While acknowledging that schools have made progress in making the school environment healthier in terms of food and beverage choices in the cafeteria, school faculty and parents are still struggling with achieving a reasonable balance when it comes to foods allowed for birthday parties, fundraisers, and holiday events. The AAP recommends that school wellness policies should avoid both prohibiting and allowing excessive consumption of added sugars; rather, they encourage allowing minimal added sugars in foods that are not highly processed but are nutrient-rich.

The Smart Snacks in Schools rule, developed by USDA, requires that snack foods and beverages served during the school day must be nutrient-dense and contain limited sugar, fat, sodium, and calories.[111]

The School Health Index (SHI) is an online tool for schools that helps schools:[112]

- Identify strengths and weaknesses of health and safety policies and programs.
- Develop an action plan for improving student health, which can be incorporated into the school improvement plan.
- Engage teachers, parents, students, and the community in promoting health-enhancing behaviors and better health.[112]

The SHI has eight different modules for elementary schools and middle and high schools in the self-assessment, which correspond to the eight components of a coordinated school health program, as depicted in Figure 12.4. Each module consists of a scorecard, a questionnaire with guidance for arriving at a score, planning questions, and recommendations for implementation. Recent versions of the SHI include an increased focus on the types of foods in the school environment, including:

- Food must not be used as a reward or punishment.
- Schools provide access to safe, free, unflavored drinking water throughout the school day.
- All foods and beverages sold or offered during the school day, including those for parties, events, and fundraisers, meet the USDA Smart Snacks in Schools standards (Figure 12.4).
- Food and beverage advertising to students is limited.

Schools are encouraged to assess their progress toward meeting these nutrition standards and to implement plans to promote continuous improvement.

competitive foods Foods sold to children in food service areas during mealtimes that compete with the federal meal programs.

12.10 Public Food and Nutrition Programs

"It is the position of the Academy of Nutrition and Dietetics that children and adolescents should have access to safe and healthy foods that promote physical, cognitive, and social growth and development. Federally funded Nutrition assistance programs . . . play a vital role in ensuring that children and adolescents have access to the foods they need. . . ."[113]

—The Academy of Nutrition and Dietetics

National child nutrition programs, which have had a federal legislative basis since 1946, contribute significantly to the food intake of school-age children. The purpose of the child nutrition programs is to provide nutritious meals to all children. These programs can also reinforce nutrition education, which takes place in the classroom. Child nutrition programs include the National School Lunch Program, School Breakfast Program, Child and Adult Care Food Program, Summer Food Service Program, and the USDA Fruit and Vegetable Program.

The National School Lunch Program

The federal government provides financial assistance to schools participating in the National School Lunch Program (NSLP) through cash reimbursements for all lunches served, with additional cash for lunches served to needy children, and through commodities.[114] Schools must meet five major requirements to participate in the NSLP:

1. Lunches must be based on nutritional standards.
2. Children who are unable to pay for lunches must receive lunches for free or at a reduced price, with no discrimination between paying and nonpaying children.

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Table 12.10 National School Lunch Program meal pattern[114]

Food Group	New Requirements K–12
Fruit and Vegetables	¾–1 cup of vegetables plus ½–1 cup of fruit per day
Vegetables	Weekly requirement for: • Dark green • Red orange • Beans/peas (legumes) • Starchy • Other (as defined in 2020 Dietary Guidelines)
Meat/Meat Alternate	Daily minimum and weekly ranges: Grades K–5: 1 oz equivalent minimum daily (8–10 oz weekly) Grades 6–8: 1 oz equivalent minimum daily (9–10 oz weekly) Grades 9–12: 2 oz equivalent minimum daily (10–12 oz weekly)
Grains	Daily minimum and weekly ranges: Grades K–5: 1 oz equivalent minimum daily (8–9 oz weekly) Grades 6–8: 1 oz equivalent minimum daily (8–10 oz weekly) Grades 9–12: 2 oz equivalent minimum daily (10–12 oz weekly)
Whole Grains	All grains must be whole grain rich.
Milk	1 cup Must be fat-free (unflavored/flavored) or 1% low-fat (unflavored)

Source: U.S. Department of Agriculture, Food and Nutrition Service, www.usda.gov.

3. The programs operate on a nonprofit basis.
4. The programs must be accountable.
5. Schools must participate in the **commodity program**.

Nutrition standards for the National School Lunch and School Breakfast Programs require:

- Offering both fruits and vegetables every day of the week; substantially increasing offerings of whole grain–rich foods
- Offering only fat-free or low-fat milk varieties
- Limiting calories based on the age of children being served to ensure proper portion size
- Increasing the focus on reducing the amounts of saturated fat, *trans* fats, and sodium

The NSLP meal pattern is required to provide one-third of the DRIs based on the child's age or grade group (Table 12.10). In addition, school food-service personnel must make food safety a priority. These programs must also meet the needs of children with disabilities and special health-care needs (Chapter 13). Although not federally mandated, schools are encouraged to allow adequate time for children to eat their meals; at least 15 minutes for breakfast and 20 minutes for lunch. Schools receive payments from the federal government based on the number of meals served by category (paid, free, or reduced-price).

School Breakfast Program

School breakfasts must provide one-fourth of the DRIs for the children being served, based on age or grade groups, and comply with the U.S. Dietary Guidelines for Americans when analyzed over a week's time (Table 12.11). It is a special challenge for schools to allow enough time for school breakfasts before school when most of the participating children arrive at about the same time.

Impact of the Healthy, Hunger-Free Kids Act

Implementation of new standards introduced in the Healthy, Hunger-Free Kids Act (HHFKA) of 2010 was met by many challenges. Among the biggest concerns were those related to increased cost, increased food waste from children not eating the foods served, and children choosing not to participate in the programs. In addition, both students and parents initially complained about the amount and types of foods offered, primarily in secondary schools. Research has begun to assess the impact of HHFKA on a range of outcomes, including nutritional quality of the

commodity program A USDA program in which food products are sent to schools for use in the child nutrition programs. Commodities are usually acquired for farm price support and surplus-removal reasons.

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Table 12.11 School Breakfast Program meal pattern

Food Group	Requirements K–12
Fruit	1 cup per day (vegetable substitution allowed)
Grains and Meat/Meat	Daily minimum and weekly ranges for grains:
Alternate (M/MA)	Grades K–5: 1 oz equivalent minimum daily (7–10 oz weekly) Grades 6–8: 1 oz equivalent minimum daily (8–10 oz weekly) Grades 9–12: 1 oz equivalent minimum daily 9–10 oz weekly) Schools may substitute M/MA for grains after the minimum daily grains requirement is met.
Whole Grains	All grains must be whole grain rich.
Milk	1 cup Must be fat-free (unflavored/flavored) or 1% low-fat (unflavored)

Source: U.S. Department of Agriculture, Food and Nutrition Service, www.usda.gov.

meals chosen and participation in the program. One large longitudinal study demonstrated that the nutritional quality of the meals students chose increased, while calories decreased since implementation of the new standards.[115] These improvements in dietary intake were attributed to decreased portion sizes, increased food variety, and increased intake of fruits and vegetables. In this study, no significant difference in meal participation was seen. Similarly, a large assessment of participation in four mostly elementary, low-income, high minority public school districts in New Jersey demonstrated no change in NSLP participation, and an increase in participation in the National School Breakfast Program participation since 2014.[116]

Summer Food Service Program

The Summer Food Service Program provides meals to children from needy areas when school is not in session. Schools, local government agencies, or other public and private nonprofit agencies operate these programs. The federal government gives financial assistance to these programs for providing meals in areas where 50 percent or more of the participating children are from families whose incomes are lower than 185 percent of the poverty level. The Summer Food Service Program is an important source of food for many children from food-insecure families.

Farm to Schools

The HHFKA also places an emphasis on the importance of increasing fruits and vegetables in the diets of school-aged children and challenged schools to participate in Farms to Schools (FTS) programs.[117] Implementation of FTS has included a variety of activities: buying locally grown fruits and vegetables to serve in the school cafeteria; planting school gardens to give students hands-on experience with growing food; and nutrition education about the value of including fruits and vegetables in the diet, and how to prepare and serve them. In 2015, the USDA conducted a census of approximately 42,000 schools, representing 5,200 school districts, who were participating in the FTS program.[117] They found that these schools had spent more than $790 million on locally grown product in the previous school year, helping to grow the local economy.

Another measure of the success of FTS programs is an increase in the amount of fruits and vegetables students eat in schools who participate in the program. A study measuring plate waste, or the amount of food that is not eaten and is left on the plate at the end of the meal showed that children in schools that were participating in FTS wasted significantly less fruits and vegetables, leading the authors to conclude that eating locally grown produce had a positive effect on the children's overall intake of fruits and vegetables.[118] More research is needed to measure the long-term impact of this program, but early results are promising.

Impact of COVID-19 Pandemic on Food Security of School-Aged Children

The COVID-19 pandemic had a significant impact on the food security of children who rely on meals provided through the National School Lunch, School Breakfast, and Summer Food Service Programs. When schools were required to close in March 2020, the USDA implemented a waiver allowing states to serve all children, regardless of financial need, up to 18 years of age with two meals or snacks per day through the Summer Food Service Program.[119] When children were required to attend school remotely, school districts established pickup sites or home delivery methods to ensure food security of children. Districts that resumed in-person instruction continued to provide free meals to all children under this waiver. The waiver program was discontinued at the end of the 2021–2022 school year.

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Key Points

1. School-age and preadolescent children continue to grow at a slow, steady rate until the adolescent growth spurt.
2. Monitoring BMI-for-age percentiles is important for screening for overweight or underweight.
3. Family mealtimes should be encouraged, as there is a positive relationship between families eating together and the overall quality of the child's diet.
4. A child's food choices are being influenced by peers, teachers, coaches, the media, and the Internet.
5. The prevalence of overweight and obesity continues to increase in the school-age and preadolescent groups but may be leveling out.
6. Complications of overweight and obesity in children and adolescents, such as type 2 diabetes mellitus, are increasing.
7. Sedentary lifestyles and limited physical activity are contributing factors to the increase in childhood overweight.
8. School-age and preadolescent children are encouraged to eat a variety of foods and increase physical activity as outlined by the U.S. Dietary Guidelines for Americans and MyPlate.
9. Consumption of sweetened soft drinks, which increases as children get older, is associated with increased calorie consumption and poorer diet quality.
10. Schools play an important community role in promoting healthy nutrition and physical activity patterns for children and adolescents.

Review Questions

Tyler, in Case Study 12.1, returns to his pediatrician 6 months later at 7½ years of age for a weight check. He has gained 10 kg in 6 months and now weighs 90 lb (41 kg). His height has increased to 51 in. (130 cm).

1. Calculate Tyler's BMI.
2. What is Tyler's BMI-for-age percentile? Use CDC growth curves to determine percentile.
3. Which of the following classifies Tyler's BMI-for-age percentile?
   a. Healthy weight
   b. Overweight
   c. Class I obesity
   d. Class II obesity
4. Based on the staged treatment plan for pediatric obesity, describe the recommended approach to treatment for Tyler.
5. Regarding fluid intake in school-age children, which of the following statements is most correct?
   a. Soft drinks are good choices for hydration during exercise because the high carbohydrate content provides quick energy.
   b. Children's caffeine consumption decreases as they get older.
   c. Diluted fruit juice is a good choice for hydration during exercise, as children are more likely to drink it than water.
   d. Adults who are supervising children during exercise can rely on the children to let them know when they are thirsty.
6. Name two strategies for increasing a school-age child's physical activity.
7. Name two strategies for decreasing a school-age child's sedentary behaviors.
8. Regarding child nutrition programs, which of the following statements is correct?
   a. The nutritional analysis of the School Lunch Program includes à la carte items.
   b. Meals served as part of the School Lunch Program must provide one-third of the DRIs of key nutrients for the age of the children being served.
   c. Meals served as part of the School Breakfast Program must provide one-third of the DRIs of key nutrients for the age of the children being served.

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Amanda Mills/Center for Disease Control and Prevention

13

Child and Preadolescent Nutrition

Conditions and Interventions

Prepared by Beth L. Leonberg

Learning Objectives

After studying the materials in this chapter, you should be able to:

13.1 Explain why thinking that children are children first, even if they have conditions that affect their growth and nutritional requirements, suits child developmental milestones.

13.2 Identify the common nutrition problems in children with special health-care needs and chronic conditions.

13.3 Describe how a growth assessment is modified in children with special health-care needs.

13.4 Characterize nutrition recommendations for children who are underweight and overweight, or have difficulties meeting known nutrient requirements.

13.5 Describe the eating and feeding problems of children with special health-care needs and chronic conditions.

13.6 Compare use of dietary and herbal remedies in children with and without special health-care needs.

13.7 Explain why children who have special health-care conditions receive more intensive nutrition services in schools and health-care settings than other children do.

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Introduction

Providing adequate nutrition services to all children, regardless of their disease or condition, is critical to helping children reach their full potential. This chapter discusses the nutrition needs of children with chronic conditions, such as cystic fibrosis (CF), diabetes mellitus, cerebral palsy (CP), food allergies, phenylketonuria (PKU), and behavioral disorders. Nutrition recommendations for these children are based on those for children without diseases or conditions, but they may be modified by the condition and its consequences on growth, nutrient requirements, and/or eating abilities. Other factors, such as activity, that may increase or decrease energy needs are also discussed. School and community resources include nutrition services for children with special health-care needs, chronic conditions, or those with developmental disabilities. Advocates for those with disabilities prefer "people-first language," which this chapter models. This convention names the person first and then the condition. An example is "a child with Down syndrome."

13.1 "Children Are Children First"—What Does That Mean?

Children with special health-care needs are children first, even if their conditions change their nutrition, medical, and social needs. Children are expected to become more independent in making food choices, assisting with meal preparation, and participating at mealtime with other family members. These same expectations are appropriate for children with special health-care needs. For example, the child with spina bifida should be encouraged to make a salad or set the table. Modifications may be needed to help the child be successful, such as storing plates and utensils on low shelves, or lowering counter heights to accommodate a wheelchair at a kitchen sink.

This concept has been acknowledged in schools through federal legislation in the Individuals with Disabilities Education Act (IDEA) (refer also to Chapter 11 for further discussion).[1,2] This law requires the least restrictive environment and results in inclusive settings, especially in public schools, for more children with disabilities.[1] This concept of inclusion has major ramifications for how children receive all types of services, such as schools providing alternative foods as required in the main cafeteria. As a result of inclusion, children who use wheelchairs or who have Down syndrome spend time in regular classrooms with others of the same age. Nutritional problems related to food refusals, mealtime behavior, or special nutrition interventions are addressed in the neighborhood school, in the regular classroom, as often as possible.

This same concept of treating the child as a child first is recommended at home, too. Whatever special foods or dietary supplements that may be required are in forms suitable for the child's developmental level, such as a liquid supplemental calcium instead of chewable tablets for younger children. At the same time, children with diabetes or PKU do not benefit from being treated in a special manner at mealtime. As soon as possible, children are taught to take responsibility for making food choices consistent with their dietary plans. Consistency and structure in the home support a child's normal development. This structure includes regular meal and snack times, and the child accepting increasing levels of responsibility in preparing foods. These approaches provide opportunity for children to "become more independent in making food choices, assist with meal preparation, and participate at mealtime with other family members."

Including Children with Special Health-Care Needs

School-aged children with special health-care needs are categorized differently than those under 5 years of age. While a specific medical diagnosis is not required to provide educational services for younger children, special educational services for those 8 years and older require categories similar to a medical diagnosis for insurance coverage, and is subject to state-by-state guidelines. For children older than 3 years of age, the planning document used to outline services the child will need is called the individualized education plan (IEP). U.S. education laws specify that by 8 years of age, stricter classifications of disability become the basis for eligibility.[2]

Because of this distinction, the Centers for Disease Control and Prevention (CDC) is conducting ongoing research on the prevalence of autism spectrum disorder (ASD) among 8-year-old children.[3] ASD is a lifelong developmental disability, characterized by limited patterns of behavior, activity, or interests, and difficulty in social interaction and communication. The prevalence of ASD has been rising rapidly; the CDC reports that the prevalence in 2020 was about 1 in 44 8-year-old children, as compared to about 1 in 68 8-year-old children in 2010 or 1 in 150 children in 2000.

Estimates range widely about the number of children with chronic conditions and those with special health-care needs. Some factors that influence these estimates includes the duration of the condition, whether families, health-care providers or educators are reporting, and who is making the diagnosis. The National Survey of Children's Health, conducted by the Health Resources and Services Administration (HRSA) Maternal and Child Health Bureau, reports data based on a survey of parents of children who meet the following criteria:[4]

- "Need or use of prescription medication(s)
- Elevated need or use of medical care, mental health, or education services
- Functional limitation(s) (that limit daily activity)

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- Need or use of special therapies (e.g. physical, occupation or speech therapy)
- Emotional, developmental or behavioral problem for which treatment or counselling is needed."

According to this survey, in 2019–2020 almost 20 percent of all American children had a special health-care need, representing approximately 14.1 million children.[4]

According to the U.S. Department of Education, approximately 7.3 million children between the ages of 3 and 21 received special education services in 2019–2020, or about 14 percent of all public school students.[5] Of the approximately 7.3 million children in schools in 2019–2020, approximately 33 percent had a specific learning disability, 19 percent had a speech or language impairment, 15 percent had another health impairment, 11 percent had autism, 7 percent had developmental delay, 6 percent had intellectual disability, and 5 percent had emotional disturbance.[5]

General nutrition guidelines for children, school nutrition educational materials, and nutrition prevention strategies may or may not be applicable to children with specific conditions. Many nutrition education curricula target the goals of preventing overweight, lowering fat and sodium intake, and increasing fruit and vegetable intake, which are appropriate for children and those with conditions such as diabetes and Down syndrome. However, children with conditions in which slow weight gain and underweight are common, such as CP and CF, may not fit this curricula, since these children need high-fat foods as part of high energy needs. Similarly, a child with PKU can never have protein-rich meats or dairy products. When the usual nutrition guidelines are discussed and encouraged, the child with PKU may feel isolated and confused about whether their restricted dietary selections are healthy. Whenever possible, children with special health-care needs are encouraged to participate in school nutrition education programs, with modifications as needed.

"Train a child in the way he should go, and when he is old, he will not depart from it."

—Proverb

13.2 Nutritional Requirements of Children with Special Health-Care Needs

In general, energy and protein needs are lower on a body-weight basis in childhood than during the preadolescence, toddler years, and preschool years.[6] However, children with special health-care needs have a wide range of nutrition requirements and more variability than typical children do, based on multiple factors:[7,8]

- Low energy intake may be appropriate with small muscle size.
- High protein is needed with high protein losses, such as skin breakdown.
- High fluid volume is needed with frequent losses from vomiting or diarrhea.
- High fiber may be needed for chronic-constipation management.
- Long-term use of prescribed medications may increase or decrease vitamin or mineral requirements, or change the balance of vitamins and minerals needed as a result of medication side effects.
- Routine illness is more likely to result in hospitalization or resurgence of symptoms of the underlying disorder.

U.S. Dietary Guidelines and the Healthy People 2030 objectives may not fit some children with special health-care needs.[9] In these cases, what replaces these tools is the individualized nutrition assessment that results in nutrition diagnoses and interventions.[8] Nutrition diagnoses should augment and align with medical diagnoses within the child's medical and educational records.

Energy Needs

Children with special health-care needs may need more, less, or the same amount of energy as other children of the same age. Energy needs are amazingly complex in children, let alone those with special needs. Under ideal conditions, the child's energy needs would be measured by indirect calorimetry, but, because this is not routinely available, they are usually estimated using standard calculations that cannot take into account the specific conditions involved.[8] Conditions that slow growth or decrease muscle size generally result in lower energy needs.[7,8] For example, energy needs in a child with Prader–Willi syndrome may be only 80 percent of the energy needs of a child of the same age and sex without the syndrome.[10]

Energy requirements are related to activity level and frequency of illnesses.[7] The level of activity of children with chronic conditions may be higher or lower than activity levels in other children. Children with a chronic condition are encouraged to participate in age-appropriate sports activities; activity may be especially beneficial for children with diabetes and mild CP. Children who are very active may appear thin as a result of low energy intake. Children with ASD and ADHD are generally more active and/or they may sleep less.[11] A thorough nutrition assessment will include questions about the child's activity level. The health-care provider should ask questions such as: "Is the child involved in any after-school sports or activities?" "Is the child receiving physical therapy? How many times per week?" "How much time does the child use a walker compared to a wheelchair?"

Protein Needs

Protein is crucial for wound healing and for maintaining a healthy immune system; it is also a key requirement for various conditions with frequent illnesses or surgeries. For example, a child with CP who is scheduled to have

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hip surgery would have protein needs evaluated in a complete nutritional assessment.[12] Higher protein may be recommended for wound healing and the prevention of skin breakdown while in a cast after surgery.

Similar to energy needs, protein needs may also be higher than, lower than, or the same as those for other children, based on the child's condition. For example, a child with healing burns or CF has high protein needs—at 150 percent of the DRI.[7] In contrast, children with conditions such as PKU and other protein-based inborn errors of metabolism require greatly reduced amounts of dietary protein. Children with many other chronic conditions, such as diabetes mellitus, have the same protein needs as other children.[7]

Children eat foods providing intact protein, but some conditions require protein that is in the form of hydrolyzed amino acids or specific amino acid mixtures rather than intact protein. Children with severe egg, soy, or milk allergies, chronic gastrointestinal conditions, or with inborn errors of metabolism are usually prescribed a complete nutritional supplement to fit their specific altered protein requirement.[13]

Other Nutrients

The DRIs are a good starting place to assess the need for vitamins and minerals for children with chronic conditions.[6] As in all children, if the allowed food selections provide enough choices to meet the child's needs for protein, fats, and carbohydrates, it is likely that vitamin and mineral needs will also be met. However, children with chronic conditions may have more difficulty meeting the DRI for vitamins and minerals as a result of the following considerations:[6]

- Eating or feeding problems may restrict intake of foods requiring chewing, such as meats, so that certain minerals usually contributed by meats may be low.
- Prescribed medications and their side effects can increase turnover for specific nutrients, raising the amount needed.
- Food refusals are common with recurrent illness, so total intake may be more variable day to day than in other children of the same age.
- Treatment of the condition necessitates specific food and nutrient restrictions, so that vitamins and minerals usually provided in restricted foods have to be supplemented.

Nutrients such as calcium that are low in the general population of children are also problem nutrients for children with chronic conditions. Children with neurologic impairment and developmental disabilities, such as CP, are at higher risk for osteopenia due to low mineral intakes, lack of weight-bearing activity, and use of anticonvulsant medications.[7] Vitamin D intake should be monitored and supplemented as needed in these children.

13.3 Growth Assessment

The World Health Organization (WHO) growth charts for children 0–2 years of age and CDC growth charts for 2–20 years of age are a good starting place for assessing the growth of all children.[14] Public health goals, such as identifying children at risk for overweight and preventing long-term cardiovascular risks, are important purposes underlying growth assessments of children. However, these concerns may not be considered to be the most important issues for children with chronic conditions. Within the nutrition assessment process, a child's specific condition should be used to create individualized nutrition goals for weight gain and growth.

Children with special needs require in-depth growth assessments because interpretation of weight and height in the manner used for other children can be misleading. For example, body mass index (BMI) is a good indicator of growth for typical children. However, BMI has underlying assumptions about body composition that do not fit children with CP, so better indices based on weight and long-term mortality are recommended for children with CP.[12] Researchers have developed specialized growth charts, using populations of children who have conditions that are known to affect growth. These include specialized growth charts for children with CP, Down syndrome, and many other syndromes (refer to section "Specialized Growth Charts" later in the chapter).[15]

If the nutritionist is especially skilled in interviewing families, parents may be willing to express their apprehension about weight gain and growth in their child. They may have long-term concerns about caring for the child at home, when activities such as lifting him or her from the bathtub or out of a wheelchair may become more difficult. Also, children with degenerative conditions such as **spinal muscular atrophy (SMA)** have such major decreases in muscle size that growth may not occur.[16]

Most children with chronic conditions do grow, and assessing growth is an important component of nutrition services. If the child's condition is known to change the rate of weight or height gain—either slowing or accelerating it—the following signs need to be monitored regardless of what growth chart is used:

- A plateau in weight
- A pattern of weight gain followed by weight loss
- Not regaining weight that was lost during an illness
- A pattern of unexplained and unintentional weight gain

spinal muscular atrophy (SMA) Condition in which muscle control declines over time as a result of nerve loss, causing death in childhood.

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Growth Interpretation in Children with Chronic Conditions

What a child eats usually does impact their growth. In children with chronic conditions, however, this may or may not be the case. Factors that affect growth assessment and interpretation in childhood are the age of onset of the condition, **secondary conditions**, and activity. These factors might not have been detectable earlier in younger children.

The child's age when the condition started should influence growth interpretation. The fetal origins hypothesis (discussed in Chapter 9) supports this idea; early onset of a condition is more likely than later onset to affect growth in children with short stature, seizures, and asthma.[17,18,19] Such conditions are now understood to reflect fetal programming that overrides the impact of current food and nutrient intake on growth. Global maternal and health data on growth stunting have shown that the process begins *in utero*, even though the diagnosis is made years later.[17]

Children who were born with severe prematurity may have experienced undernutrition that results in unusual growth patterns, in spite of adequate food and nutrition in childhood. Even though infants and young children are not diagnosed with asthma until childhood, the developmental origins of asthma are seen in low-birthweight infants who require respiratory support.[19] Nutritionists use such information to interpret growth and help avoid frustration for families who are told to increase energy for a child to promote growth, which does not end up showing any benefit.

Another example of the impact of the age of onset of a chronic condition on growth interpretation is in children with seizures. If the child's seizures started in middle childhood, the standard growth chart may be appropriate because the child's growth pattern is already established. Onset of seizures in younger years requires careful interpretation of growth, as uncontrolled seizure or medication side effects on food and nutrient intake may slow growth rate. This is another example of when the child's own growth record over time would be the best indicator of future growth.

Children, but not toddlers and preschoolers, with CP are assessed for developing secondary conditions.[12] **Scoliosis** is a secondary condition that interferes with accurate measurement of stature. It may develop as a result of muscle incoordination and asymmetrical weakness in one group of muscles. If a child with CP has stature measurements that plateau or decline, it may be a result of CP, scoliosis, lack of adequate nutritional intake, or a combination of these three factors. Nutritional interventions cannot prevent scoliosis, although nutritional consequences of its treatment may arise. Children may be provided with custom-fitted back braces, so weight gain means the brace needs to be replaced. Children with scoliosis braces also may become less active because the brace restricts some types of movement. If scoliosis surgery is performed, the child may become slightly taller immediately, again showing that stature measurements have to be interpreted with care.

secondary condition Common consequence of a condition, which may or may not be preventable over time.

scoliosis Condition in which the vertebral bones in the back show a side-to-side curve, resulting in a shorter stature than expected if the back were straight.

neuromuscular Term pertaining to the central nervous system's control of muscle coordination and movement.

Body Composition and Growth

Nutritionists use body composition as another factor in interpreting growth in an in-depth assessment. Children with special health-care needs may or may not be typically proportioned in muscle size, bone structure, and fat stores. Some children with good nutritional status may plot at or below the lowest percentile on a standard growth chart for height. In fact, low-percentile heights are usual for a child with Down syndrome if growth is plotted on the CDC chart. Short stature, low muscle tone, and low weight compared to age-matched peers should not be attributed to low energy intake. They characterize the natural consequences of the **neuromuscular** changes within Down syndrome and are typical for children in this population.

Similarly, a child with low muscle size could have a low weight and short stature (muscle contractions cause resistance, which promotes skeletal growth) compared to children with regular-sized muscles.[12] It would be unfair to assume that the child's food choices result in a low weight in this example. Conditions with altered muscle size may be described using terms such as *hypotonia* or *hypertonia*. Examples include CP, Down syndrome, and spina bifida. Not all muscles are affected. For example, some children with spina bifida have larger muscle size in the upper body and smaller muscle size in the lower body. Variation in size of muscles may make growth interpretation more difficult. Standard interpretation may suggest a risk of overweight, but it may not accurately reflect that short stature is part of the child's condition (Case Study 13.1).

A thorough assessment that includes body composition is necessary, including measurement of fat stores in a standard manner, like upper arm circumference and skinfold thickness.[8,20] A thin-appearing child needs to have body fat stores measured before nutrition recommendations are made; if body fat stores are fine, adding food as extra energy just contributes to overweight. Measuring fat stores in children is not like measuring fat stores in adults, because of the changes in body composition that come with age and growth. Calculated methods for evaluating body composition in children are not the same as those for adults.[12,21] Estimates of body composition for

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Case Study 13.1 Adjusting Energy Intake for a Child with Spina Bifida

This case study is about appropriate nutrition interventions, monitoring, and evaluation within the Nutrition Care Process. The nutrition diagnosis is excess energy intake related to spina bifida as evidenced by weight gain over the last year.

Santiago is a third-grader in regular classes at his public school. He uses a wheelchair all the time and can transfer from his wheelchair to a chair by himself. He is on a toileting schedule at school with the assistance of a nurse. He participates in modified physical education as part of his physical therapy treatment. He likes to eat with his friends at school. His mother tries to make him cut back at the evening meal and has stopped buying some of his favorite snacks. He is mad at his mother because he likes his snacks after school when he is bored.

Nutrition assessment from Santiago's last visit at the spina bifida clinic at the local hospital showed that he was overweight by measuring his fat stores. Because he cannot stand, his stature was estimated by measuring his length lying down and comparing it with his last length measurement. Standard methods could not be used to measure him, which limits the interpretation of his growth using the CDC growth chart. The chart showed Santiago at the 75th percentile in weight for his age, which is not overweight for his age. His rate of weight gain of 8 lb per year, typical for a boy his age, is too fast for his low level of activity. His estimated energy need is 1,100 calories per day due to low activity and short stature, or about two-thirds of the energy needs of others his age. Santiago says he does not care about his size or being overweight. His mother is quite concerned that she would not be able to assist him if he fell or needed to be lifted.

Interventions: The nutritionist at the clinic completes a school lunch prescription to reduce Santiago's energy intake from 650 cal to 350 cal per lunch. His meal pattern is adjusted to two meals (breakfast and lunch) and two snacks per day at home, which better fits his low energy needs. Santiago is allowed to choose his favorite snack foods to replace his evening meal. Giving him choices about his snacks increases Santiago's sense of being in control and lowers the instances of expressing anger at his mother about snack foods. The clinic nutritionist calls the school to review Sanitago's level of activity and confirm that the lunch changes are being implemented. His physical therapist has found after-school swimming lessons and recommends them to Santiago's mother as a way to increase his activity and socialization.

To motivate Sanitago to pay attention to his eating and weight gain, his teacher and his mother set up a monthly nonfood reward for him if his weight remains stable. The effectiveness of the plan to cut Santiago's energy intake and increase his activity will be assessed at his next clinic visit, when he will be weighed and have his fat stores measured.

Questions

1. Since Santiago is not concerned about his size or being overweight, why is implementing a healthy eating pattern necessary?
2. What are the risks from Santiago's weight, since he is only at the 75th percentile for his age on the standard growth chart?
3. Will Santiago grow taller when he goes through puberty and be able to eat more each day?



BSIP/Universal Images Group/Getty Images

children with chronic conditions may be based on smaller sample sizes than for other children, but such information is still helpful. Identifying low fat stores can trigger recommendations to boost food energy to improve body composition.

The use of prescription growth hormone is another major factor in interpreting growth.[22] It is now prescribed for a variety of conditions, including children with CF, Down syndrome, Prader–Willi syndrome, and other chromosomal disorders. If a child is prescribed growth hormone, the time of initiation and discontinuation should be noted during the growth assessment, so that growth patterns may be interpreted correctly.

In-depth growth assessment may include head circumference measurement for all ages, with plotting and interpretation based on the Nellhaus head circumference growth chart, as discussed in Chapter 9.[23] Head circumference is important because children with unusually small heads have smaller brains, a characteristic associated with short stature. Even with good food choices and no eating problems, children with some genetic disorders tend to be shorter than their age-matched peers.[24]

Specialized Growth Charts

Specialized growth charts have been published for a variety of genetic conditions (Table 13.1).[25] The number of children

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Table 13.1 Examples of specialized growth charts[25]

Conditions with Specialized Growth Charts	Comment
Achondroplasia	Form of dwarfism
Down syndrome Trisomy 13 Trisomy 18	Short stature, variable weight
Fragile X syndrome	Short stature, primary in males
Prader–Willi syndrome	Short stature, overweight
Rubinstein–Tabyi syndrome	Short stature
Sickle-cell disease	Short stature
Turner syndrome	Short stature
Spastic quadriplegia	Short stature, low weight
Marfan syndrome	Tall stature

used to develop these growth charts is not as large, nor as representative as the WHO and CDC growth charts.[14] Specialized growth charts are revised often, based on new information emerging about the natural course of rare conditions. For example, new growth charts for those with Down syndrome were developed and published in 2015, reflecting newer data.[26] Some specialized growth charts are based on only the most severe forms of the condition, such as for children living in residential care. Many chronic conditions have such a wide range of severity that specialized growth charts cannot be developed. Conditions without a specialty growth chart in which growth patterns can be variable include the following:

- **Juvenile rheumatoid arthritis**
- Cystic fibrosis
- Rett syndrome
- Spina bifida
- Seizures
- Type 1 and type 2 diabetes

juvenile rheumatoid arthritis Condition in which joints become enlarged and painful as a result of the dysfunction of the immune system; generally occurs in children or teens.

13.4 Nutrition Recommendations

Children with chronic conditions require nutrition assessments to determine whether they are meeting their nutrient and energy needs. Then nutrition diagnoses and interventions should be developed based on the information gained in the assessment. The more frequent nutrition diagnoses are derived from assessments showing underweight and overweight, or having difficulties meeting known nutrient requirements. The goal is for the child to maintain good nutritional status, and to prevent nutrition-related problems from being superimposed on the primary condition. (Refer to Case Study 13.1.)

Children with special health-care needs benefit from the same nutritional recommendations that other children do, particularly in general areas such as dietary fiber or appropriate intake of fluids (Photo 13.1). Often children with special health-care needs have nutritional diagnoses and interventions that require particular supplements and methods of delivering energy and nutrients not needed for other children their age.



Edwin Remsberg/Alamy Stock Photo

Photo 13.1 Children with special needs still need to follow general dietary guidelines.

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The starting place for nutrition interventions is to view the child in the context of their family. The goal is for the child to live at home and be educated in spite of their health-care needs. This requires close attention to meeting all known food and nutrient requirements. Most children with and without special health-care needs eat and drink to obtain their needed nutrients and energy, like everyone else. Nutrition experts are involved mainly with those children who are unable to meet their needs in the usual way. They range from children who need just a little help to those who are technology dependent for both eating and breathing.[27]

The quality of the children's life, their ability to live at home and avoid frequent hospital visits, and the ability of the parents to work and take care of other family members are examples of factors that need to be considered in planning nutrition interventions.[27,28] Nutrition interventions may include prescribing nutrition products that are digested in the usual manner, termed enteral supplements, to maintain health and to assure growth is not being limited (Table 13.2).[8] Children less than 10 years of age are generally prescribed a pediatric form, but adult complete nutritional supplements may be safely consumed by children. (Energy and nutrients that do not go into the gastrointestinal tract but, rather, directly into the blood stream is called parenteral nutrition. [Chapter 9].)

Methods of Meeting Nutritional Requirements

Since feeding a child is such an important part of caring for him, nutritionists give parents and caregivers a large role in deciding about the type and form of nutrition support provided. Part of the decision-making process often hinges on trying various interventions to improve nutrition status. A common nutrition intervention is supplementing or partially replacing meals or snacks with complete nutritional supplements consumed orally. Most complete nutritional supplements can be consumed as beverages.

If this does not improve nutrition status over time, complete nutritional supplements can be administered through a feeding *gastrostomy, which is a tube placed semi-permanently through the abdominal wall*.[28] Most families experience difficulty accepting a gastrostomy for meeting nutritional requirements because feeding a child is seen as such an important aspect of parenting.[28] Medical providers conduct the tests and surgical procedures to create a gastrostomy and monitor it over time; nutrition experts recommend what goes into the gastrostomy to meet nutrition requirements. Children who have a gastrostomy may or may not also require other types of technology, such as mechanical pumps. Sometimes the term *technology dependent* is used when technology is required for feeding and breathing. Gastrostomy feeding may be required in children with kidney diseases, some forms of cancer, and severe forms of CP and CF.[27-29] Insurance coverage and financial questions of paying for complete nutritional supplements are major concerns for some families.

Children fed by gastrostomy can have many different schedules, such as eating orally during the school day and being supplemented by gastrostomy feeding overnight (Table 13.3). If medications are required, they can also be given through the gastrostomy. For example, for children with pediatric AIDS who require many medications during the day, compliance with taking the drugs improved after gastrostomies were placed.[30,31] The parents spent less time trying to administer the medications to their children, and some children's health improved as a result of taking all of the required medications. Another example is a child who cannot safely drink liquids as a result of CP. The child could have fluids given by gastrostomy but eat solid foods. Children with gastrostomies can swim, bathe, and do any activities they could do before the gastrostomy was placed.

When possible, gastrostomy feeding is planned as a temporary measure, with a return to oral eating later. For example, a child who has a gastrostomy because of a kidney condition may have a kidney transplant that allows removal of the gastrostomy after recovery. Other nutrition supplements fed by gastrostomy have specific components that cannot be in beverages because they have such a strange taste. For example, those containing individual amino acids generally are accepted only by those used to this taste from infancy, such as the metabolic foods prescribed for those with PKU. If a child required a new product with amino acids in place of intact protein, he or she

Table 13.2 Examples of nutritional supplements and formula for children[8]

Formula	Comments
Pediatric versions of complete nutritional supplements, such as PediaSure	Generally recommended for children under 10 years of age; can be used for gastrostomy or oral nutrition support
Adult complete nutritional supplements, such as Ensure	Generally 1 cal per mL strength is recommended for children
Enrichment of beverages, such as Carnation Instant Breakfast added to milk	Requires that milk is tolerated
Predigested formula with amino acids and medium-chain fatty acids, such as Peptamen Junior	For conditions in which intestinal absorption may be impaired
Special formulas for inborn errors of metabolism (PKU), such as Phenex-2	Usually a powder that is mixed as a beverage, but other forms such as bars and capsules are available
High-energy booster for cystic fibrosis, such as Scandishake	Generally 2.5 cal per mL to concentrate energy in a small volume

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Table 13.3 Example of a feeding and eating schedule for an 8-year-old who eats by mouth and by gastrostomy

Daily Schedule	Comments
6:30 a.m. Night feeding pump turned off 7:15 a.m. Breakfast: refused 8:00 a.m. Bus to school 11:30 a.m. School lunch offered and about half is eaten: ½ chicken sandwich, all of French fries, with ⅓ pint of whole milk 3:30 p.m. After-school snack at home of 4 oz fruit yogurt, two plain cookies, and 4 fl oz orange juice 6:30 p.m. Evening meal at home: ½ cup mashed potato, 6 fl oz whole milk, refused vegetable and meat 8:30 p.m. Bedtime	Overnight feeding by gastrostomy runs from 9:30 p.m. until 6:30 a.m., providing about 3 fl oz per hour, so no hunger in the morning is common Child has slow eating pace and is easily distracted by school lunchroom sounds Mealtime behavior at home includes many attempts to leave the table, with prompting to eat from parents Parents hook up night feeding pump while the child is sleeping

will probably reject drinking it. Administering the product through a gastrostomy would be more successful in improving nutritional status over time.

Vitamin and Mineral Supplements for Chronic Conditions Children's complete vitamin and mineral supplements are recommended for a variety of chronic conditions to assure that the DRIs for essential nutrients are provided. However, most over-the-counter (OTC) supplements are in the form of chewable tablets, so children who cannot chew well may require a liquid form of vitamins and minerals. The composition of vitamin and mineral supplements may be important because some have ingredients that are not allowed. Examples are vitamin and mineral brands with added carbohydrates, which are not allowed on a **ketogenic diet**, or those made with an artificial sweetener containing phenylalanine not recommended for children with PKU. (The ketogenic diet and PKU are discussed later in this chapter.)

The underlying diagnosis can make specific nutrients so important that they may be prescribed as pharmaceuticals. CF treatment (discussed later in this chapter) requires fat-soluble vitamin supplements due to poor intestinal absorption of these nutrients; vitamins A, D, E, and K are all supplemented in those with CF.[7] Vitamin B_{12} injections are needed for some protein-based inborn errors of metabolism.[7] Vitamin C may be prescribed above the DRI for some children with spina bifida who have frequent bladder infections.[7] The high dose of vitamin C functions as a medication rather than as a nutrient in this instance.

All medications, prescribed and OTC, should be identified in a nutrition assessment. Excessive amounts of vitamins and minerals can be consumed inadvertently through a combination of diet and supplements, and can be risky, especially for underweight children.

ketogenic diet High-fat, low-carbohydrate meal plan in which ketones are made from metabolic pathways used in converting fat as a source of energy.

osteoporosis Condition in which low bone density or weak bone structure leads to an increased risk of bone fracture.

A family may be told to give the child a commercially available liquid nutrition supplement daily by one provider, while another provider is unaware that the child also takes a chewable children's vitamin/mineral tablet. The result would be excessive intake of vitamins and minerals; this is why determination of the total intake of supplemented nutrients is part of a nutrition assessment.

Children with chronic conditions that limit activity or require medications that affect bone growth need special attention to their calcium and vitamin D intake.[28] Galactosemia, in which all food choices with lactose are eliminated, and CP are two examples of conditions affecting calcium. Some children with these conditions are like older women with **osteoporosis** in that their calcium may move out of bones faster than it goes in. Providing additional calcium, phosphorus, and vitamin D may be recommended, raising concerns about supplements needed for years or decades.[28]

Fluids

Guidelines for fluids for all children are appropriate to use for children with special health-care needs. However, extra considerations for children with special health-care needs are high fluid losses—for example, from uncontrollable drooling—or problem behaviors that result in low fluid intakes.[8] Children with limited ability to talk may have more difficulty indicating thirst. Because constipation is common in children with neuromuscular disorders, adequate fluids are often stressed as part of a bowel management program. Many chronic health conditions carry higher risks for dehydration due to side effects of prescribed medications. A chronic condition generally does not change the fluid requirement when the child is well.

13.5 Feeding Disorders in Children with Special Health-Care Needs

In spite of it being something we do regularly from birth, feeding is a complex activity that requires psychological input, development of oral, fine and gross motor skills, adequate neurologic signals, and normal physiological functions.[32] Pediatric feeding disorders are defined as "impaired oral intake that is not age appropriate, and is associated

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with medical, nutritional, feeding skill, and/or psychosocial dysfunction." A variety of health-care providers are involved in the process of assessment, diagnosis, and treatment of pediatric feeding disorders, including radiologists, occupational therapists, speech therapists, registered dietitians, pediatricians, and psychologists. When drinking and eating is unsafe, raising the risk of respiratory failure, nutrition interventions to avoid eating by mouth are lifesaving. Parents and caregivers recognize over time that children who cannot eat independently nor enjoy mealtimes need help with eating and its stressful impact on both the family and the child. A recent study of pediatric feeding disorders among children 1–5 years revealed that their prevalence ranges from approximately 1 in 23 to 1 in 37 children.[33]

Feeding Challenges for Children with Health-Care Needs

Examples of these feeding problems for children with special health-care needs and chronic conditions include the following situations:

- Self-feeding skills are lower than the child's chronological age, requiring assistance and supervision to ensure adequate intake.
- Meals take so long or so much food is lost in the process of eating that the actual food intake is too low.
- The condition requires adjustment in the timing of meals and snacks at home and at school.

In children without intellectual disabilities, eating problems may include behavioral problems at mealtimes, conflicts about control over food choices, and variability in appetite. Families of children with chronic conditions may focus on mealtimes and foods as methods of coping with their own concerns about the child. For example, families may be overprotective and restrict a child from eating at friends' homes, when such activities may be appropriate for social development.

13.6 Nutrition Needs of Children with Specific Disorders

This section highlights the nutrition problems and interventions for school-aged children with several common or unique diagnoses: Cystic fibrosis, diabetes mellitus, seizures, cerebral palsy, inborn errors of metabolism, attention-deficit hyperactivity disorder, and food allergies. While some of these are relatively common conditions, others are relatively rare but require careful nutrition management.

Cystic Fibrosis CF is one of the most common genetic disorders, with an incidence of 1 in 1,500–2,000 live births.[8] It has a higher incidence among European Americans, and is less common in African Americans. The mutation occurs in the cystic fibrosis transmembrane conductance regulator (CFTR) gene, located on the long arm of chromosome 7, and it has hundreds of gene versions. The most common genetic mutation characterizes 67 percent of the cases. CF affects all the exocrine organs in the body, with lung complications often causing death during the adult years. Its major nutrition-related consequence is malabsorption of various nutrients, especially fat and fat-soluble vitamins, due to the lack of pancreatic enzymes. This can result in a slower rate of weight and height gain, and higher energy needs due to chronic lung infections. Children with CF require close monitoring to avoid malnutrition as the condition progresses. Intensive nutrition interventions may be required to meet higher energy needs.[7, 34]

Nutrition interventions for CF include monitoring growth, assessing food and nutrient intake, and increasing energy and fat to compensate for malabsorption.[7] Pancreatic enzyme replacement therapy (or PERT) is used to help break down food and ensure nutrients can be absorbed. Frequent calorie-dense meals and snacks are encouraged to provide adequate energy. Gastrostomy tube feeding at night to boost energy is sometimes required. Vitamin and mineral supplementation, particularly fat-soluble vitamins, is a part of daily management. Children with CF are at risk for developing diabetes because the pancreas is a target organ of CF damage.[34] Nutrition experts, such as Registered Dietitian Nutritionists, work hard to balance the children's high nutrient needs with their frequent illnesses that can further increase energy needs but decrease appetite. Adequate nutrition and growth are extremely important since research has demonstrated that nutritional status and growth are positively associated with better pulmonary function.[35] Some children with CF have lung transplants if they meet strict eligibility requirements. CF is on the leading edge of gene therapy research and has new medications in development, giving hope to families with young children.

Diabetes Mellitus Diabetes mellitus is a disorder of glucose metabolism and **insulin** regulation in which nutrition intervention is crucial.[7,36] Early signs of abnormal glucose regulation, such as insulin resistance, have been found in the childhood years in those born preterm and in those with unusual patterns of catch-up growth.[37] Type 1 diabetes is related to immune function and results in virtually no insulin production. Children with type 1 diabetes have both high and low blood sugars, not just high blood sugars, as in type 2 diabetes.[36] Increasingly, children with type 1 diabetes mellitus are managed with insulin pumps set to inject small amounts of insulin continuously and in response to meals. Continuous insulin pumps change food timing and nutrition guidelines from those older guidelines based on using less frequent injections of different types of insulin and also from those for managing type 2 diabetes.

insulin Hormone usually produced in the pancreas to regulate movement of glucose from the bloodstream into cells within organs and muscles.

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The prevalence of both type 1 and type 2 diabetes among U.S. youth (up to 20 years of age) has been increasing over the past 20 years. In 2011–2012, 17,900 children and adolescents had type 1 diabetes, and another 5,300 children aged 10–19 years of age had type 2 diabetes. This increase in prevalence has occurred across all gender and racial groups. However, new cases of type 1 diabetes are highest in non-Hispanic Whites, while new cases of type 2 diabetes are highest in non-Hispanic Black Americans and Native Americans.[38] Currently, type 2 diabetes is most prevalent in Native American youth (at approximately 10 times the prevalence in White youth), followed by Black, Hispanic, Asian Pacific Islander, and White.[38]

Treatment for both types of diabetes includes regulation of the timing and composition of meals and exercise, along with insulin injections or medications.[36] Type 1 diabetes requires families and children to master a carbohydrate counting system for all consumed foods, as that is what is used to adjust insulin doses accompanying meals. For example, a third-grader with type 1 diabetes requires a school diabetes management plan that outlines the necessary oversight and modification of school breakfast, school lunch, and snack time based on physical activity in school and during after-school activities. If the child is invited to a birthday party, the timing of meals and snacks can be adjusted to allow the child to attend the party and eat most of the foods there. Common colds, or foods a child refuses to eat, can cause wide variation in blood sugar, contributing to irritability, sleepiness, or difficulty with schoolwork. Many localities organize summer camps for children with diabetes; food and nutrition education and controlled access to food choices are provided, along with the usual camp activities. Such disease-specific camps are good for breaking the social isolation that children experience when they feel they are the only ones required to limit food choices.

Seizures Seizures are uncontrolled electrical disturbances in the brain. Epilepsy and seizures are the same disorder. Seizure activity has a range of outward signs, from uncontrollable jerking of the whole body to mild blinking. Currently, no known nutrients bring on seizures. Children who have seizures are usually treated by medications that prevent them. After some types of seizures, the child may have a period of semiconsciousness called a **postictal state** and appear to be sleeping, but he or she is difficult to wake. Feeding or eating during the postictal state is not recommended because the child may choke. Some children have long enough postictal states to miss meals. In this case, adding other eating times is needed to make up for the lost energy and nutrients.

When seizures are controlled by medications, growth usually continues at the rate typical for that child. Food and nutrient consequences of controlled seizures are primarily related to drug–nutrient side effects, such as changes in hunger or sleepiness. Some drugs should be taken without food, and others may be offered with snacks or meals. Most drugs have to be taken on a strict schedule and cannot be stopped without medical supervision.

Some children have uncontrolled seizures that may cause further brain damage over time. For reasons that remain unknown, seizures decrease when brain metabolism is switched from the usual fuel, glucose, to *ketones* from fat metabolism.[7,39] Specialty neurology clinics administer the *ketogenic diet* for uncontrolled seizures. The diet severely limits food sources of carbohydrates and increases fat content, but is adequate in energy and protein. Vitamins and minerals have to be added as supplements because the allowed food sources of carbohydrates are not sufficient to meet vitamin and mineral requirements. The ketogenic diet may allow seizure medications to be reduced or eliminated over time.[7,39] However, many difficulties, such as measuring growth, blood glucose, and ketones in urine, lie in monitoring the body's reaction to such a severe carbohydrate restriction. Growth during the time on a ketogenic diet may be different from that seen in the child's previous pattern. Some children improve in both weight and height when seizure activity declines. The ketogenic diet is so high in fat that some children gain weight faster than expected. This diet is generally recommended for 2 years, if it is effective in reducing seizures, to optimize its effectiveness. After that time, some children are able to resume a typical diet and remain seizure free, while others may be able to control their seizures with medications.

Cerebral Palsy CP is one of the most common conditions in children with severe disabilities (Photo 13.2).


Jaren Jai Wicklund/Shutterstock.com

Photo 13.2 Boy with CP in a walker.

postictal state Time of altered consciousness after a seizure; appears to be like a deep sleep.

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Overall incidence of CP is about 1.4–2.4 per 1,000 children[40] *CP* is a general term well understood by the public; it covers a broad range of conditions resulting from brain damage. Causes of CP all involve damage to the brain early in life, either before or after birth. The initial site of brain damage does not progress, but progression of secondary effects occurs over time. Secondary effects may include contractures, scoliosis, gastroesophageal reflux, and constipation.[7] Many children with CP have constipation because coordinated muscle movements are part of bowel emptying, including the muscles in and over the intestines. Muscle coordination problems most easily seen in movements of the arms and legs may occur in muscles all over the body, including the abdominal muscles that assist in bowel evacuation.[40]

The form of CP that presents the most nutrition problems is spastic quadriplegia, involving all limbs. Most children with spastic quadriplegia appear thin, but this appearance may be a result of smaller muscle size. Children with CP often have other forms of brain damage as well: 39–44 percent have intellectual disability, 26–36 percent have seizures, and 14–18 percent have severe visual impairment.[40] Causes of CP are unknown for more than one-third of affected children, and the condition may or may not be related to preterm birth. About half the time after a preterm birth, a basis for CP can be identified from the perinatal period.[40] The prevalence of CP in children born with very low birthweight has been increasing, but this trend may be a consequence of the overall increase in survivors of severe prematurity. Children with CP can enjoy many activities, attend school, and later contribute to society. Persons with CP display a wide range of abilities. Children with spastic quadriplegia grow, but their growth is slower than that in others, with or without gastrostomy feeding (Figure 13.1).

Nutritional consequences of spastic quadriplegia are slow weight gain and other growth concerns, difficulty with feeding and eating, and changes in body composition.[8]

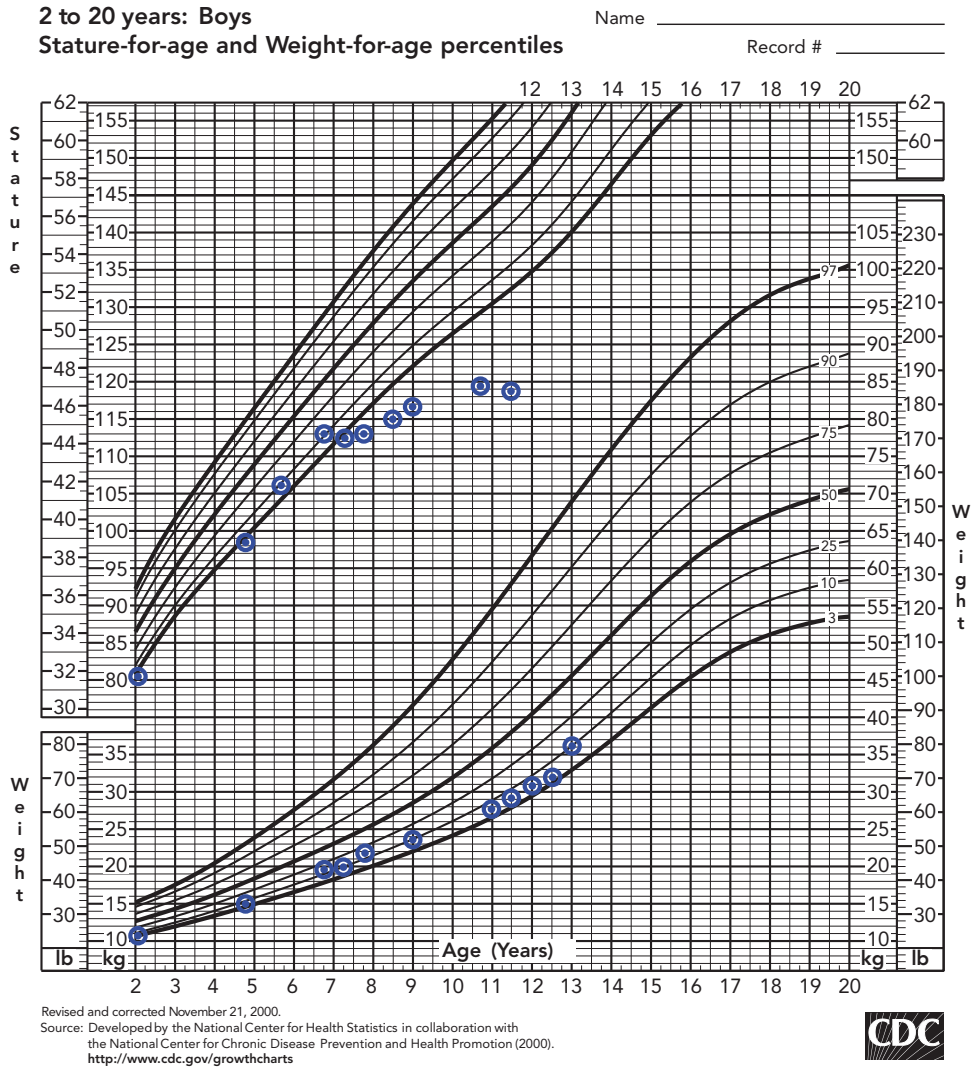


Figure 13.1 Growth chart of a child with spastic quadriplegia and scoliosis, who is fed by gastrostomy tube.

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No specific vitamins or minerals are known to correct CP. Problem nutrients are likely to be those related to bone density, calcium, and vitamin D, or nutrients needed in higher amounts as a result of medication side effects. Recommendations for energy needs are difficult to determine, even with an in-depth growth assessment. Children with small or weak muscles have lower energy needs because they are less active as a result of little voluntary muscle control. In contrast, types of CP characterized by increased uncontrolled movement require extra energy as a result of a higher activity level. **Athetosis** is an example of this less common form of CP, in which increased energy needs have been documented.[8]

Altered body composition affects many aspects of the child's nutrition and eating abilities.[25] Eating or feeding problems may appear in the forms of spilling food, long mealtimes, fatigue at mealtime, and/or requiring assistance to eat. Difficulty in controlling muscles such as those in the neck and back; those used in head position and sitting; and those in the jaw, tongue, and lips and used in swallowing may contribute to feeding and eating problems.[8,12]

Nutrition experts who provide services for children with CP assess their growth and then make recommendations for food choices that fit the children's abilities for eating, for nutritional supplements if food and beverages are not providing sufficient nutrients, and for nutrition support if needed. Nutrition interventions may include the following:

- Stimulating oral feeding
- Promoting healthy eating at school
- Adjusting menus and timing of meals and snacks at home or school for meeting nutrient needs from foods that minimize fatigue during meals
- Assessing and adjusting the child's dietary plan over time
- Using adapted self-feeding utensils or other types of feeding equipment

Inborn Errors of Metabolism PKU is a well-known example of a group of genetic disorders called inborn errors of metabolism (IEM).[7] More children are found to have inborn errors of metabolism in recent years as a result of more genetic disorders being identified with better survival after newborn screening. (Newborn screening and genetic screening are discussed in Chapter 9.) While most disorders are rare, collectively, IEM occur in approximately 1:1,000 births.[7] These disorders require interventions to manage breakdown products from foods and beverages that contain protein, fats, and carbohydrates being metabolized incompletely or inadequately. Inborn errors of metabolism involve molecular- or cellular-level blocks and have little or nothing to do with the gastrointestinal level of digestion and absorption of nutrients. Examples of inborn errors of metabolism diagnosed during childhood are glycogen-storage diseases (inborn errors of carbohydrate metabolism) and medium-chain fatty acid disorders (inborn errors of fat metabolism) diagnosed in older siblings or family members after the birth of an infant identified with the same disorder by newborn screening.

athetosis Uncontrolled movements of the large muscle groups as a result of damage to the central nervous system.

PKU best demonstrates the importance of nutrition interventions in an inborn error of metabolism. The main treatment is lifelong nutrition intervention in which more than 80 percent of protein intake from foods and beverages is replaced by a mixture of amino acids from which phenylalanine has been removed. The enzyme that uses phenylalanine as a substrate is either not working at all or only partially active in the liver of a person with PKU. For children with specific types of blood phenylalanine elevations, a prescribed medication can adjust the degree of nutrition intervention required.[41] Both medication and nutrition intervention reduce intake of this amino acid to the minimum amount needed as an essential amino acid. This strategy limits toxic breakdown products of accumulated phenylalanine, which the body has difficulty clearing. How excess phenylalanine causes intellectual disability is not known but is a side effect of PKU. The PKU diet is required throughout life. If foods with protein are consumed in too-high amounts, PKU slowly becomes a degenerative disease affecting the brain at whatever age the treatment is stopped.

When their dietary prescription is set correctly, children with PKU appear to be eating meals providing less food than the meals of other children. The diet is adequate in all vitamins, minerals, protein, fats, and energy, but more nutrients are in liquid rather than solid forms. Foods to be avoided completely are protein-rich foods such as meats, eggs, regular dairy products, peanuts, and soybeans in all forms. Allowed natural sources of protein are limited amounts of regular crackers, potato chips, rice, and potatoes. Many fruits and vegetables are encouraged, if offered without added sources of protein. Some foods that are high in fats and/or sugars and generally low in natural protein, such as fried vegetables or candy canes, are safe for children with PKU.

The phenylalanine-deficient protein is generally served as a liquid, called a medical food or formula. The vitamins and minerals required to meet the RDA are in the phenylalanine-deficient protein powder. If the child does not drink enough of the PKU formula, foods that the child eats to meet her vitamin, mineral, and energy needs will elevate the blood phenylalanine. The phenylalanine-deficient protein is also available as bars and pills (Table 13.4). It can be expensive to buy substitute low-protein alternative foods, such as low-protein pizza crusts, low-protein cheese, and low-protein baking mixes. Successful compliance requires use of low-protein foods to allow variety, such as low-protein pasta.

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Table 13.4 Food and nutrient recall for a 5-year-old child with well-controlled PKU

Breakfast
2 slices low-protein bread with jelly and margarine 6 cut-up orange pieces 8 fl oz PKU metabolic food
Lunch
½ cup fruit cocktail in heavy syrup 1 cup tossed salad (lettuce, tomato, celery, cucumber only) with 2 Tbsp ranch dressing 17 French fries with ketchup 6 fl oz apple juice
After-school snack
½ cup microwave popcorn 8 fl oz PKU metabolic food
Dinner
Pickle spears (dill, 3 wedges) 1 cup low-protein imitation rice containing 1.5 Tbsp margarine ½ cup grilled onions, green peppers, and mushrooms (on rice) 1 cup canned peaches in heavy syrup 8 fl oz PKU metabolic food
Snack
Skittles candy (small snack-size) 4 fl oz apple juice



Amanda Mills/Center for Disease Control and Prevention

Photo 13.3 The number of children reported to have ADHD is increasing.

Attention-Deficit Hyperactivity Disorder

Attention deficit disorder and ADHD are the most common **neurobehavioral** conditions in children (Photo 13.3).[42] In 2016, 5.4 million children (8.4 percent) between 2 and 17 years old were reported to have a diagnosis of ADHD.[42] About two-thirds of these children were taking medication to treat ADHD, some along with behavioral or other therapies. The most common type of medications used to treat children with ADHD are **psychostimulants**, which have a number of well-recognized side effects including decreased appetite, resulting in weight loss or slow weight gain and growth.

The effect of ADHD medications on appetite is variable; it depends on the type of medication, timing of the medications compared to meals, dosage and medication schedule, and on how long the child has had to adjust to the medication. Less interference with appetite and growth is likely if the child does not take the medication during school holidays. Long-term or continuous treatment with psychostimulants has been associated with delays in weight and height, although it's not clear whether these delays will persist into adulthood.[43]

Regardless of the child's dosage schedule, the peak activity for ADHD medication is aimed for school hours, which includes school lunch. Nutrition interventions for children on psychostimulant medications call for timing meals and snacks around the medication's action peaks. For example, adding a large bedtime snack when the medication's effects are low is a typical recommendation. Monitoring weight and height carefully over time helps identify growth plateaus. Education for the school's lunchroom supervisors and teachers may be helpful to deal with food refusals and mealtime behavior for the child with ADHD.

Children with ADHD who are not on medication may have a chaotic meal and snack pattern and the inability to stay seated for a meal. They may be given fewer opportunities to use kitchen appliances and get their own snacks due to impulsiveness. Theories about specific foods or nutrients causing ADHD have not been proven scientifically, but high interest in nutrition as a cause and treatment continues. The sale of herbal medicines and nutritional supplements to families with children with ADHD is common, however a meta-analysis of the outcomes of various therapies for ADHD did not find any evidence that these therapies are effective.[44]

neurobehavioral Pertains to control of behavior by the nervous system.

psychostimulant Classification of medication that acts on the brain to improve mental or emotional behavior.

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Table 13.5 Nutrition considerations of chronic diseases and disorders in children[7,8,34-48]

Disease or Disorder	Incidence or Prevalence	Etiology	Nutrition-Related Concerns
Cystic Fibrosis	1 in 1,500 to 2,000 live births	Genetic disorder affecting exocrine glands	Malabsorption secondary to pancreatic insufficiency; slow weight gain and growth
Diabetes Mellitus–Type 1	Approximately 18,000 U.S. children and adolescents	Autoimmune disorder affecting production of insulin	Carbohydrate intake must be controlled and matched to insulin dose
Diabetes Mellitus–Type 2	Approximately 5,300 children and adolescents aged 10–19 years	Insulin resistance induced by overweight/obesity	Carbohydrate intake must be controlled
Seizures	3.5 per 1,000 children	Abnormal electrical activity in the brain	Seizure activity may interfere with meals; management with ketogenic diet is complex
Cerebral Palsy	1.2–1.4 per 1,000 children	Brain damage *in utero* or early life	Providing adequate calories may be difficult due to high needs and altered GI function in some children
Phenylketonuria	1 in 12,000 live births	Inborn error of metabolism affecting ability to convert phenylalanine to tryptophan	Diet must be severely limited in protein
Attention-Deficit Hyperactivity Disorder	11% of children aged 4–17 years	Neurodevelopmental disorder	Psychostimulant medication causes decreased appetite
Food Allergies	10% of children	Immune-mediated reaction to peptide fragment in food	Elimination of foods or food groups may cause nutrient deficiencies

Food Allergies

Current estimates of food allergy in children range from 4 to 8 percent.[45] The most common food allergens include cow's milk, soy, egg, wheat, peanuts, tree nuts, fish, and sesame. Most food allergies present when the child is an infant or toddler. While allergies to milk and egg are often outgrown by the time a child enters school, peanut allergies are more likely to persist into middle childhood.

Education of parents and children about potential sources of peanuts, and cross-contamination of peanuts in foods, is critical. Anaphylactic reactions to peanuts account for more than 60 percent of fatalities from ingestion of food allergens. In spite of the high risk and possible consequences, unintentional exposures are a frequent occurrence, with approximately 14 percent of children having an unintentional exposure each year.[46] The diagnosis of food allergies has been shown to impact a child's life significantly. A study of the impact of peanut allergy on typical activities in which children participate showed that 68 percent of children with peanut allergy avoided parties, 59 percent avoided school trips, 26 percent avoided sleepovers, and 14 percent avoided playdates.[47] Parents and children need to be educated about options and alternatives to allow children to participate in as many activities as possible.

Of particular concern in recent years is the potential for a child with a peanut allergy to be unintentionally exposed to peanuts at school. Actions that should be taken to reduce the risk of a child with a food allergy being exposed at school include the following:[48]

- Carefully reviewing all food labels of foods given to the allergic child to identify possible allergens
- Taking precautions to avoid cross-contamination during meals, such as having a peanut-free table in the cafeteria, or during crafts, science projects, or animals visiting the classroom
- Cleaning surfaces and hands with soap and water, or disinfecting wipes
- Developing and implementing school policies about use of allergens in school. It should be noted that restricting peanuts in school has not been demonstrated to decrease the incidence of reactions and may result in a false sense of security
- Teaching the child and professional staff to recognize symptoms of a reaction, including itching, abdominal discomfort, lip or tongue swelling, difficulty swallowing or breathing, hives, severe vomiting, and fainting. Children with known severe allergies should have an epinephrine auto injector at school to be used as soon as possible when a reaction occurs
- Implementing recommendations in the CDC voluntary guidelines for managing food allergies in school[49]
- Develop written emergency action plans, such as the one available from the American Academy of Pediatrics[50]
- Keeping an unassigned epinephrine autoinjector in school in the event a child has a first time allergic reaction at school
- Training staff to recognize and respond to allergic reactions

Table 13.5 summarizes some of the important nutrition considerations for children with the chronic diseases or disorders discussed in this section.

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Table 13.5 Nutrition considerations of chronic diseases and disorders in children[7,8,34-48] (continued)

	Energy Needs	Special Nutrient Needs	Feeding Issues
	Increased as much as 150 to 200%	Water-soluble forms of vitamins A, D, E, and K; pancreatic enzymes taken with all meals and snacks	May need tube feeding to meet energy and nutrient needs for growth
	Typical	None	None
	Typical	None	None
	Typical	Ketogenic diet management requires minimal protein and carbohydrate, and very high fat diet; all intake must be carefully weighed	Ketogenic diet may be unpalatable; food choices are limited
	May be increased or decreased, depending on contractures and activity	May need additional calcium and vitamin D to prevent osteoporosis	Eating and swallowing difficulties are common. Tube feeding may be required to meet needs
	Typical	Majority of dietary protein must be provided by specialized formula that does not contain phenylalanine	Special formula provides most of calories; food choices are limited
	Typical or slightly increased for increased activity	None	Appetite and behavior may be a problem at mealtimes
	Typical	None	Potential for unintentional exposure to allergens may cause avoidance of eating outside the home

13.7 Dietary Supplements and Herbal Remedies

Children with special health-care needs are found to use complementary and alternative medicine at a higher rate, 30–70 percent, than healthy children.[51] This includes various types of nutritional supplements and vitamins and minerals.[52] Families with children in a lengthy process of diagnosis—where the diagnosis does not lead to a definite treatment and when expense, insurance-coverage, and administrative problems tax their ability to cope—are more likely to seek alternative therapies. Some of these alternatives have questionable effectiveness and are perhaps even harmful. No herbal remedies or nutritional supplements have been found effective to prevent or treat the conditions covered in this chapter; however, nutritional claims abound for various chronic conditions. Families hear from one another about micronutrients—such as magnesium, zinc, and B_6—sold with various combinations of amino acids for Down syndrome and ASDs.[53] Restrictive food choices, such as avoiding dairy products or gluten, have been researched for one condition and then extrapolated for another. Sports drinks and high-protein products marketed for athletes may attract families with children who have difficulty gaining weight.

Strategies to counter unscientific nutritional claims for various products include the following:

- Recognize the benefits of support for families, such as advocacy groups.
- Improve communication with health-care providers, so that families ask more questions about nutrition claims of alternative treatments.
- To give them some control over decision making for their children, give families reliable information, such as scientific literature or fact sheets, without endorsing any claim.

13.8 Sources of Nutrition Services

Children with special health-care needs and chronic conditions need more intensive nutrition services than healthy children. More resources are available, but due to the complexity of chronic conditions and their low frequency, problems locating quality nutrition services persist. Public health nutrition services are more widely available than nutrition services for children with chronic conditions. Here are sources to help families find the appropriate level of nutrition services in their communities.

- Supplemental Social Insurance (SSI). This is insurance coverage and financial support for low-income families with eligible children. Conditions usually eligible for SSI are chromosomal disorders; intellectual disability; and severe forms of seizures, CP, and CF. A child with treated PKU is generally not eligible for SSI because treatments prevent decline in learning abilities.
- The Americans with Disabilities Act applies to all ages. It requires, for example, that school cafeteria lines accommodate wheelchairs. The Americans with Disabilities Act may protect children from having their special food and nutrient needs being the basis for discrimination against them.
- The U.S. Department of Agriculture Child Nutrition Program (described in Chapters 1 and 11) requires

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that school breakfast and lunch menus be modified for children with diagnosis-specific dietary interventions or changes in the texture of foods. Parents who want their children to participate in the Child Nutrition Program cannot be charged an additional fee for providing prescribed food choices. Physicians complete a prescription ordering special breakfasts or lunches. Examples of diet prescription orders are a reduced-energy school lunch and breakfast, a pureed diet, or a nutrient-modified diet, such as a PKU diet (Case Study 13.2). Complete nutritional supplements administered by gastrostomy are not required to be supplied by the Child Nutrition Program.

- Department of Education public school regulations, called 504 Accommodation and IDEA, guide how schools can fund nutrition services in addition to those from the Child Nutrition Program. Children in regular education have different access to services than do children eligible for special education. They may have a 504 Accommodation that modifies the regular curriculum teaching methods to fit a child's educational needs. For example, a child with diabetes who needs a snack before physical education or a child who has refrigerated nutrition supplements may have this need described in the 504 Accommodation plan. Under IDEA, special

Case Study 13.2 Dealing with Food Allergies in School Settings

Maya is to start regular kindergarten. When she was 2 years old, she was diagnosed with a peanut food allergy after many episodes of asthma and hives. Her health has improved as a preschooler, with avoidance of peanuts in all forms. The family has carefully watched what she eats. However, at age 4, she had an episode of breathing difficulty that required an emergency-room visit. This incident makes the family quite concerned about Maya's eating at school. She is generally not allowed to go to friends' homes to play; friends come to her house so the family can watch out for her. She has been instructed not to take any food from anyone. She has not been in day care or preschool, so starting school is a big step for the family.

Interventions: A meeting was held at the school after receiving the physician's statement and diagnosis. Maya's mother met with the school staff to discuss plans for Maya at school to avoid exposure to peanuts in any form. The family did not want to participate in the school lunch program. Her mother proposed to pack Maya a lunch from home, although most children eat food provided at school. With the school staff, Maya's mother discussed snack time for Maya and her eating at the cafeteria, which periodically serves food cooked in peanut oil, or food containing peanuts. The snack at kindergarten was discussed, as it is provided by parents based on a rotation schedule. It is usually milk or juice with cookies or fruit.

Monitoring Recommendations: A plan was put in place for the teacher to check the snack foods and offer a replacement snack provided by Maya's mother if she is unsure whether that day's snack contains peanuts. The school working group had written out a 504 Accommodation plan for Maya's peanut allergy. It included making sure that tables where children eat peanut-containing foods are washed well, with signs in the cafeteria with Maya's picture to make sure she does not inadvertently get peanut-containing food from another child or in a food activity.

After Maya has been in school for 1 month, the family meets with the school group. In that month, two episodes resulted in what may have been hives, and her family is worried that Maya is not adjusting well. At snack time, Maya did not recognize some of the foods; she refused to eat a snack most days. She appeared hungry at home after school. Her mother says she would like to send to school a snack that she knows her daughter will eat, and she wants to attend school during snack time to make sure Maya is not being teased.

Questions

1. Why is it the school's job to check for peanuts when other parents are sending snacks?
2. Do you think Maya's mother's reaction to the situation is reasonable? Are there any alternative accommodations you could recommend?
3. What are the chances that Maya will outgrow the peanut allergy by next year?



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education services may have specific nutrition services written into a child's IEP[1,2] (Table 13.6). For this particular plan, the child's education includes learning to eat by mouth with prompting and assistance. Nutritional supplements may be purchased as part of an education intervention called for in the child's IEP. For a child with PKU, diabetes, or another chronic condition, the food intake restrictions apply to classroom birthday parties or when food is used in classroom projects. These regulations do not apply in private schools.

- U.S. Department of Health and Human Services (HHS) Maternal and Child Health block grants designate a portion of funding for services for children with special health-care needs in every state.[54] Nutrition services may be funded in specialty clinics, in county health departments, or contracted from community nutrition providers. Thus, nutrition experts can work with children in various settings, including schools, early-intervention programs, homes, clinics, and facilities.
- Every state identifies, advocates, and trains parents to be advocates for children with special needs. An example is the Developmental Disabilities Council in each state.

Table 13.6 Example of nutrition objectives in an individualized education plan for an 8-year-old boy with limited oral feeding skills

1. In three of five trials, J. R. will hold food on the spoon as he moves it to his mouth without hand-over-hand assistance from his aides during three meals per week.
2. J. R. will point to what he wants to eat with his left hand in three trials after two prompts per meal, three days each week.
3. J. R. will cooperate in having his gastrostomy site checked at feedings by pulling up his shirt three days in a row each week.

Key Points

1. Children with chronic health conditions still want to fit in with everyone else and be treated like others their age. Paying too much attention to their special needs may not help them become independent over time.
2. Nutrition requirements have to be customized to the individual and their needs.
3. Energy needs are based on the child's activity as affected by the underlying condition; calories each day may be higher or lower than others of the same age.
4. Eating problems are likely to interfere with appetite and meal patterns for conditions that require medications that have side effects.
5. The goal for meeting nutritional needs is to eat by mouth, if this is enjoyable and safe. An alternative may be to drink complete nutritional supplements or add overnight feedings.
6. Vitamins and minerals are needed for some conditions at levels that are higher or lower than usually recommended.
7. Nutrition interventions for CF and diabetes mellitus are examples of lifelong approaches that align with medical treatment for children with special health-care needs.
8. CP is one of the more severe conditions in which nutritionists assess how growth and eating are impacted, and offer interventions suited to the child rather than standard growth and eating guidelines.
9. Children with special health-care needs attend school like everyone else, but they may need to have a modified school lunch or eat different foods than others based on their underlying condition.
10. Nutrition and medical providers help families find in their communities the educational, medical, and specialty services suitable for their children.

Review Questions

1. Which child requires an interpretation of growth modified from the usual CDC growth chart interpretation?
   a. A child with ADHD
   b. A child with type 1 diabetes
   c. A child with mild cerebral palsy with scoliosis
   d. A child with PKU
2. Which child requires in-depth nutrition assessment due to changes in body composition?
   a. A child with drug–nutrient interactions that increase sleepiness
   b. A child who appears thin and uses a wheelchair most of the time
   c. A child with seizures with a BMI at the 50th percentile
   d. A child with ASD who looks thin and refuses a variety of foods

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3. When a child has a chronic condition that limits activity, such as spina bifida, what is the greatest long-term nutrition concern?
   a. Protein limiting growth
   b. Modified food textures to avoid eating difficulties
   c. Excessive calorie intake further limiting mobility
   d. Intake of calcium and vitamin D to prevent bone fractures
4. An 8-year-old child with diabetes is eating birthday cake at school. What is a likely explanation?
   a. The child has type 2 diabetes and has obesity.
   b. The child has type 1 diabetes and he has adjusted his insulin pump to cover the cake.
   c. The child's chronic condition is not managed well, as cake is not allowed.
   d. The child had eaten a high-protein food with little carbohydrate at lunch.

Ava has a chronic condition with a pattern of weight gain and then loss, without growth over the last year. Identify as true or false statements 5, 6, and 7.

5. Ava's condition can modify her energy needs compared to other children.

   _____ True _____ False
6. The family may be worried about handling Ava if she grows as expected for her age.

   _____ True _____ False
7. Ava's nutritional intake must not be sufficient, since her growth is not as expected.

   _____ True _____ False
8. What are two examples of family support that would assist a child with a chronic condition?
9. When a child with ADHD refuses to eat, what are two possible explanations?
10. Explain why a child could need an IEP that includes nutrition services.

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14

Adolescent Nutrition

Prepared by Jamie Stang

Learning Objectives

After studying the materials in this chapter, you should be able to:

14.1 Explain why sexual maturity and biological maturity (biological age) are better determinants of nutritional needs than chronological age.

14.2 Explain how the psychosocial developmental stages of adolescence, including levels of abstract reasoning and critical thinking abilities, affect the types of health education messages and intervention components that are effective with teens.

14.3 Describe at least three eating behaviors commonly seen among adolescents and the potential consequences of these behaviors on nutritional status.

14.4 Compare which food groups and nutrients adolescents consume in lower than recommended amounts and which food groups and nutrients they consume in higher-than-recommended amounts, and how these behaviors may impact overall health status.

14.5 Identify the key components of nutrition assessment and screening of adolescents and how resulting data can be used during nutrition education and counseling.

14.6 Describe the roles that peers, families, schools, and communities play in determining the dietary behaviors and nutritional status of adolescents.

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Introduction

Adolescence is usually defined as the period of life between 11 and 21 years of age. It is a time of profound physical, emotional, and cognitive changes during which a child develops into an adult. Physical, psychosocial, and cognitive maturity are largely accomplished during this life stage (Figure 14.1). In the United States, adolescence is often viewed as a tumultuous, irrational phase that children must go through. However, this view does disservice to its developmental importance. The tasks of adolescence, comparable to those experienced during early childhood, include the development of a personal identity and a unique value system separate from parents and other family members, a struggle for personal independence accompanied by the need for economic and emotional family support, and adjustment to a new body that has changed in shape, size, and physiological capacity. When adolescence is viewed in light of these dramatic developmental tasks, it can be appreciated as a unique, positive, and integral part of human development.

Nutritional Needs in a Time of Change

The physical, psychosocial, and cognitive changes associated with adolescence have direct effects on nutritional status. The dramatic physical growth and development experienced by adolescents, which matches and can even exceed the rate of growth experienced during infancy, significantly increases their needs for energy, protein, vitamins, and minerals. However, the simultaneous search for personal autonomy and peer acceptance that characterizes adolescent psychosocial development often leads to the development of health-compromising eating behaviors, such as meal skipping and the adoption of unhealthy weight control behaviors. These behaviors may create a challenge for health-care professionals, but can also become opportunities for teens to change at a time during when adult health behaviors are being formed.

This chapter provides an overview of normal biological and psychosocial growth and development among adolescents and how these experiences affect the nutrient needs and eating behaviors of teens. Common concerns related to adolescent nutrition and effective methods for educating and counseling teens are also discussed. Health conditions that require specific nutrition interventions such as obesity and eating disorders are discussed in Chapter 15.

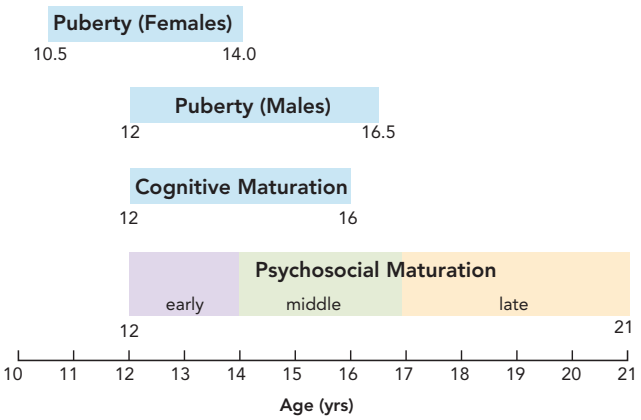


Figure 14.1 Average ages of pubertal, cognitive, and psychosocial maturation.

Source: R. L. Johnson (1988). "Adolescent Growth and Development". In A. Hofmann and D. Greynaus (eds.) *Adolescent Medicine*, 2e., McGraw Hill Companies.

secondary sexual characteristics Physiological changes that signal puberty, including enlargement of the testes, penis, and breasts and the development of pubic and facial hair.

14.1 Normal Physical Growth and Development

Early adolescence encompasses the occurrence of puberty, the physical transformation of a child into a young adult. The biological changes that occur during puberty include sexual maturation, increases in height and weight, accumulation of skeletal mass, and changes in body composition. Even though the sequence of these events during puberty is consistent among adolescents, the age of onset, duration, and tempo of these events may vary a great deal between and within individuals. Thus, the physical appearance of adolescents of the same chronological age covers a wide range. These variations in development directly affect the nutrition requirements of adolescents. A 14-year-old male at birth who has already experienced rapid linear growth and muscular development will have noticeably different energy and nutrient needs than a 14-year-old male peer who has not yet entered puberty. For this reason, sexual maturation should be used to assess biological growth and development (or biological age), and the individual nutritional needs of adolescents rather than chronological age. In addition, physiology should be used to determine the nutritional needs of adolescents as opposed to gender self-identity, since nutritional needs are based on physiological functioning. Approaches to nutrition education and behaviour modification or counselling, which are more related to social-emotional development than physiology, are best determined by gender self-identification.

Sexual Maturation Rating (SMR), also known as *Tanner Stages*, is a scale of **secondary sexual characteristics** that allows health professionals to assess the degree of pubertal maturation among adolescents, regardless of chronological age (Table 14.1). SMR is based on breast development and the appearance of pubic hair among people who are biologically a woman, and on testicular and penile development and the appearance of pubic hair among individuals who are biologically a man.[1] SMR stage 1

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Table 14.1 Sexual maturity rating for girls and boys

Stage Girls	Breast Development	Pubic Hair Growth
1	Prepubertal; nipple elevation only	Prepubertal; no pubic hair
2	Small, raised breast bud	Sparse growth of hair along labia
3	General enlargement of raising of breast and areola	Pigmentation, coarsening, and curling, with an increase in amount
4	Further enlargement with projection of areola and nipple as secondary mound	Hair resembles adult type, but not spread to medial thighs
5	Mature, adult contour, with areola in same contour as breast, and only nipple projecting	Adult type and quantity, spread to medial thighs
Stage Boys	**Genital Development**	**Pubic Hair Growth**
1	Prepubertal; no change in size or proportion of testes, scrotum, and penis from early childhood	Prepubertal; no pubic hair
2	Enlargement of scrotum and testes; reddening and change in texture in skin of scrotum; little or no penis enlargement	Sparse growth of hair at base of penis
3	Increase first in length, then width of penis; growth of testes and scrotum	Darkening, coarsening, and curling; increase in amount
4	Enlargement of penis with growth in breadth and development of glands; further growth of testes and scrotum, darkening of scrotal skin	Hair resembles adult type, but not spread to medial thighs
5	Adult size and shape genitalia	Adult type and quantity, spread to medial thighs

Source: Tanner, J. M. (1962). *Growth at Adolescence*, 2nd Edition, Blackwell Publishers.

corresponds with prepubertal growth and development, while stages 2 through 5 denote the occurrence of puberty. At SMR stage 5, sexual maturation has concluded. Sexual maturation correlates highly with linear growth, changes in weight and body composition, and hormonal changes.[1]

Puberty usually occurs earlier among individually who are biologically a female than those who are biologically a male, with a 2.5-year gender difference on average.[2] There is a great deal of variation in the timing of puberty based on racial and ethnic background, however. The National Health and Nutrition Examination Study III (NHANES III) found that non-Hispanic Black and Mexican American women experienced thelarche (breast development, SMR stage 2) at 9.6 years, which was about 8 months earlier than White women.[2] Early thelarche (by age 9.6 months) was twice as common among girls experiencing obesity, suggesting that variations in body weight and composition may play a role in ethnic and racial differences in the onset of puberty. Pubarche (the presence of pubic hair, SMR stage 3) was found to occur approximately 1 year earlier among Black girls compared to White or Mexican American girls as well.[2] Among men, pubarche occurred approximately 6 months earlier among White and Black men compared to Mexican American men; however, no significant relationship between pubarche and body weight or composition was noted among adolescent men.

The onset of **menses** and changes in height relative to the development of secondary sexual characteristics that occur in women during puberty are shown in Figure 14.2. **Menarche** occurs 2–4 years after the initial development

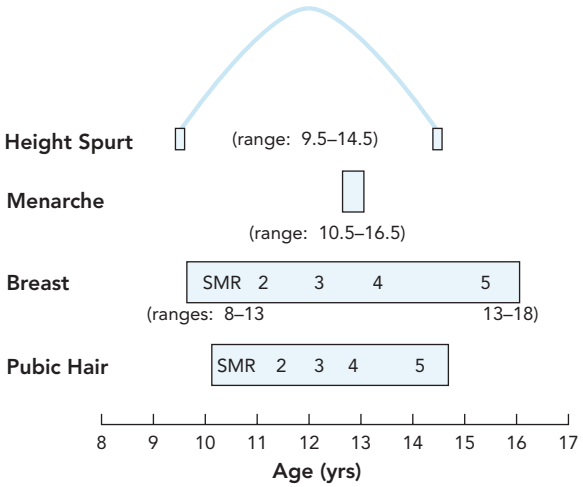


Figure 14.2 Sequence of physiological changes during puberty in females.

Source: Tanner, J.M. (1962). *Growth at Adolescence*, 2nd Edition, Blackwell Publishers.

of breast buds and pubic hair, most commonly during SMR stage 4. The average age of menarche is 12.5 years, but menarche can occur as early as 8 years or as late as 17 years of age.[2] Early onset of menarche (by age 10.6 years) is four times more likely among girls experiencing obesity than

menses The process of menstruation.
menarche The occurrence of the first menstrual cycle.

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those who are at a lower body weight. Menarche may be delayed in highly competitive athletes or in girls who severely restrict their caloric intake to reduce body weight.

The onset of the linear growth spurt occurs most commonly during SMR stage 2 in girls, beginning between the ages of 9.5 and 14.5 years in most girls (Figure 14.2). Peak velocity in linear growth occurs during the end of SMR stage 2 and during SMR stage 3, approximately 6–12 months prior to menarche. As much as 15 to 25 percent of final adult height will be gained during puberty, with an average increase in height of 9.8 in. (25 cm).[3] During the peak of the adolescent growth spurt, girls gain approximately 3.5 in. (8–9 cm) a year. The linear growth spurt lasts 24–26 months, ceasing by age 16 in most women. Some female adolescents experience small increments of growth past age 19 years, however. Linear growth may be delayed or slowed among those who excessively restrict their caloric intake.

Enlargement of the testes and change in scrotal coloring are most often the first signs of puberty among male adolescents (Figure 14.3), occurring between the ages of 10.5 and 14.5 years, with 11.6 years being the average age. The development of pubic hair is also common during SMR stage 2. Testicular enlargement begins between the ages of 9.5 and 13.5 years in male adolescents (SMR stage 2 to 3) and concludes between the ages of 12.7 and 17 years. The average age of spermarche (the age at which via sperm is produced by the tests) is approximately 14 years among male adolescents.

On average, peak velocity of linear growth among males occurs during SMR stage 4, coinciding with or just following testicular development and the appearance of faint facial hair. The peak velocity of linear growth occurs at 14.4 years of age, on average. At the peak of the growth spurt, male adolescents will increase their height by 2.8–4.8 in. (7–12 cm) a year. Linear growth will continue throughout adolescence, at a progressively slower rate, ceasing at about 21 years of age. The use of stimulant medications for conditions such as attention-deficit hyperactivity disorder has been suggested to reduce or delay linear growth velocity among male adolescents, with effects most pronounced among 14- to 16-year-olds.[4] Higher doses of stimulant medication appear to be associated with more pronounced variations in linear growth velocity. Due to the smaller number of female adolescents using these medications, it is not clear if this phenomenon also occurs among girls.

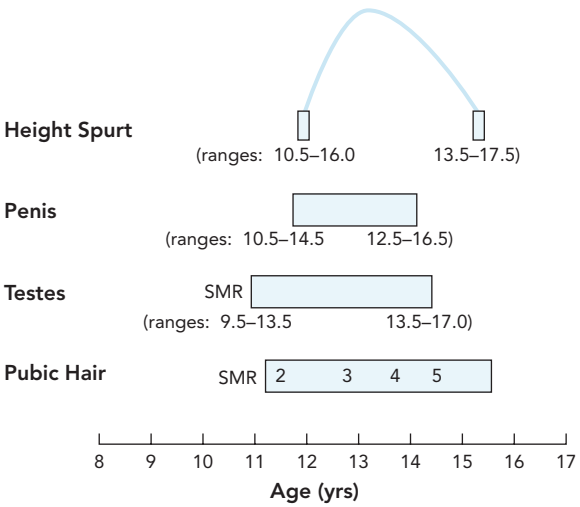


Figure 14.3 Sequence of physiological changes during puberty in males.

Source: Tanner, J. M. (1962). *Growth at Adolescence*, 2nd Edition, Blackwell Publishers.

fasting Going 24 hours or more without eating.

Changes in Weight, Body Composition, and Skeletal Mass

As much as 50 percent of ideal adult body weight is gained during adolescence. Among female adolescents, peak weight gain follows the linear growth spurt by 3–6 months. During the peak velocity of weight change, which occurs at an average age of 12.5 years, girls will gain approximately 18.3 lb (8.3 kg) per year.[3] Weight gain slows around the time of menarche, but will continue into late adolescence. Female adolescents may gain as much as 14 lb (6.3 kg) during the latter half of adolescence. Peak accumulation of muscle mass occurs around or just after the onset of menses.

Body composition changes dramatically among female adolescents during puberty, with average lean body mass falling from 80 to 74 percent of body weight while average body fat increases from 16 to 26 percent at full maturity. Females experience a 44 percent increase in lean body mass and a 120 percent increase in body fat during puberty.[5] Female adolescents gain approximately 2.5 lb (1.14 kg) of body fat mass each year during puberty. Body fat levels peak among females between the ages of 15 and 16 years. Research by Frisch suggests that a level of 17 percent body fat is required for menarche to occur and that 25 percent body fat is required for the development and maintenance of regular ovulatory cycles.[6] Normal changes in body fat mass can be mediated by excessive physical activity and/or caloric restriction.

Even though the accumulation of body fat by female adolescents is obviously a normal and physiologically necessary process, they often view it negatively. Weight dissatisfaction is common among female adolescents during and immediately following puberty, leading to potentially health-compromising behaviors such as excessive caloric restriction, **fasting**, use of diet pills or laxatives, and, in some cases, the development of body image distortions and eating disorders (Chapter 15).

Among male adolescents, peak weight gain coincides with the timing of peak linear growth and peak muscle mass accumulation.[3] During peak weight gain, male

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adolescents gain an average of 20 lb (9 kg) per year. Body fat decreases in males during adolescence, resulting in an average of approximately 12 percent by the end of puberty.

Almost half of adult peak bone mass is accrued during adolescence, thus adolescence is a critical time for osteoporosis prevention.[7] A variety of factors contribute to the accretion of bone mass, including genetics, hormonal changes, weight-bearing exercise, cigarette smoking, consumption of alcohol, and dietary intake of calcium, vitamin D, vitamin K, phosphorus, boron, strontium, magnesium, and iron.[7] Bone is composed largely of calcium, phosphorus, and protein. A great deal of bone mass is accrued during adolescence, making adequate intakes of these nutrients critical to support optimal bone growth and development.

14.2 Psychosocial and Cognitive Development

During adolescence, individuals develop a sense of personal identity, a moral and ethical value system, feelings of self-esteem or self-worth, and a vision of occupational aspirations.[8,9] While each individual experiences psychosocial development at their own rate, it is most readily understood when it is divided into three periods: early adolescence (11–14 years), middle adolescence (15–17 years), and late adolescence (18–21 years). Each period of psychosocial development is marked by the mastery of new emotional, cognitive, and social skills.

During this stage of biological changes, young adolescents experience the development of body image and an increased awareness of sexuality are central psychosocial tasks during this period of life.[9] The dramatic changes in body shape, size, and composition can cause a great deal of ambivalence among adolescents, often leading to the development of poor body image and sometimes leading to disordered eating if not addressed by family or health-care professionals (Chapter 15).

The wide chronological age range during which pubertal growth and development begins and proceeds can become a major source of personal dissatisfaction for some adolescents. Male adolescents who enter puberty late often feel physically inferior to their peers who mature earlier and may resort to the use of anabolic steroids and other supplements in an effort to increase linear growth and muscle development. Female adolescents who mature early have been found to have more eating problems and poorer body image than their later-developing peers.[10] They are also more likely to initiate risky behaviors such as smoking, drinking alcohol, and engaging in sexual intercourse at an earlier age.[10,11] Education of young adolescents on normal variations in tempo and timing of growth and development can help facilitate a positive self-image, which may reduce the likelihood of engaging in health-compromising behaviors.

Peer influence is very strong during early adolescence.[8,9] Young teens, conscious of their physical appearance and social behaviors, strive to fit in with their peer group. The need to fit in can affect nutritional intake among adolescents. Qualitative research has revealed that situational factors, such as who students ate with and where they ate, were important factors in the food choices they made.[12,13] Consequently, teens express their ability and willingness to fit in with a group of peers by adopting food preferences and making food choices based on peer influences and by refuting family preferences and choices. In some cases, choices based on peer pressure can lead to improved dietary intake, such as reduced intake of animal protein due to moral (animal welfare) concerns or choosing foods that are sustainably produced. In other cases, the choices based on peer pressure may lead to poor dietary intake, such as frequent consumption of fast foods, convenience foods, sweetened beverages, and other highly processed foods that are high in added fats and sugars.

Cognitively, early adolescence is a time dominated by concrete thinking, egocentrism, and impulsive behavior.[8,9] Abstract reasoning abilities are not yet developed to a great extent in most adolescents, limiting their ability to understand complex health and nutrition issues. Young adolescents also lack the ability to see how their current behavior can affect their future health status or health-related behaviors. This can make nutrition education efforts difficult unless the messages provided focus on how nutritional status and eating behaviors can impact daily concerns, such as physical attractiveness, academic ability, or physical performance.

Middle adolescence marks the development of emotional and social independence from family, especially parents. Conflicts over personal issues, including eating and physical activity behaviors, are heightened during mid-adolescence. Physical growth and development are mostly completed during this stage.[9] Body image issues are still of concern, especially among male adolescents who are late to mature and female adolescents.[10,11] Peer groups become more influential, and their influence on food choices peaks, which can lead to the initiation of health-compromising behaviors such as fasting, use of diet pills and laxatives, and alcohol use. Adolescents lack the ability to connect current behaviors with future health outcomes and often believe they are invincible during this stage of development.

The emergence of abstract reasoning skills occurs rapidly during middle adolescence. However, these skills may not be applied to all areas of life.[8,9] Adolescents will revert to concrete thinking skills if they feel overwhelmed or experience psychosocial stress; thus, health information should be presented in very concrete, understandable examples. Toward the end of this phase, some teens begin to understand the relationship between current health-related behaviors and future health, even though their need for peer acceptance may supplant this understanding.

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Late adolescence is characterized by the development of a personal identity and individual moral beliefs.[8,9] Physical growth and development is largely concluded, and body image issues are less prevalent. Older teens become more confident in their ability to handle increasingly sophisticated social situations, which is accompanied by reductions in impulsive behaviors and peer pressure. Adolescents become less economically and emotionally dependent on parents. Relationships with one individual become more influential than the need to fit in with a large group of peers. Personal choice emerges and can affect eating behaviors in both positive and negative ways. For instance, some individuals become more health conscious as they approach young adulthood, and may improve eating habits. Other older adolescents become less influenced by parental advice regarding eating, thus may rely more on convenience and fast foods. The use of motivational counseling methods is recommended during this phase to engage older adolescents in making health and nutrition choices.

Abstract thinking capabilities are realized during late adolescence, which assists teens in developing a sense of future goals and interests. Adolescents are now able to understand the perspectives of others and can fully perceive future consequences associated with current behaviors. This capability is helpful in nutrition counseling to reduce chronic disease risk factors and is especially important among female adolescents who become pregnant.

14.3 Health and Nutrition-Related Behaviors During Adolescence

Eating patterns and behaviors of adolescents are influenced by many factors in addition to peer attitudes and behaviors, including parental modeling, food availability, food preferences, cost, convenience, personal and cultural beliefs, mass media, and body image. Teens report that food preferences, accessibility of foods, cost, busy schedules, and social support from family and friends are key factors in their food choices.[12,13]

Figure 14.4 presents a conceptual model of the many factors that influence eating behaviors of adolescents. The model depicts three interacting levels of influence that impact adolescent eating behaviors: personal or interpersonal, environmental/community, and macrosystem. Personal and interpersonal factors that influence eating behaviors include family and peer attitudes and beliefs, food preferences, role modeling, self-efficacy, and biological/physical changes. These are daily influences that may have a profound effect on food choices. Environmental/community factors include food availability in schools and communities, accessibility of fast-food outlets and convenience stores, and social and cultural norms. These factors can either prohibit or promote access to healthy food choices. Macrosystem factors, which include food production and distribution systems

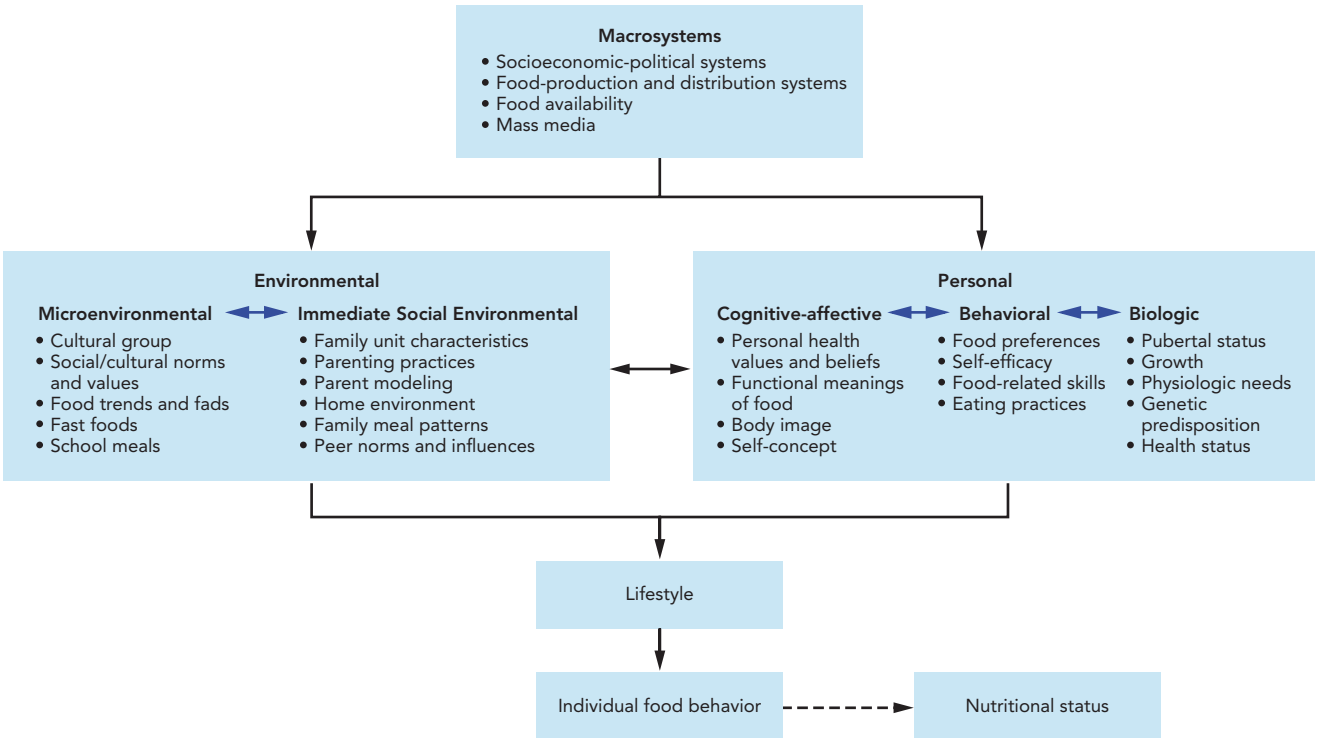


Figure 14.4 Conceptual model for factors influencing eating behavior of adolescents.

Source: From M. Story and I. Alton, "Becoming a Woman: Nutrition in Adolescence," in D. A. Krummel and P. M. Kris-Etherton (Eds.), in *Nutrition in Women's Health*. Gaithersburg, Maryland: An ASPEN Publication, 1996.

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and mass media and advertising, play a more distal and indirect role in determining food patterns, yet can exert a powerful influence on specific food choices. To improve the eating patterns of youth, nutrition interventions should be aimed at each helping the youth understand the three levels of influence.

Eating habits of people are not static; they fluctuate throughout the life span. Using Healthy Eating Index (HEI) 2015 scores as a measure of dietary adequacy, data suggest that dietary intake is higher among adults 65 years and older and children under the age of 5 years, and lowest among adolescents.[14] The lower scores for adolescents may result from increasingly hectic schedules and greater perceived barriers to healthy eating as adolescents mature and take on additional responsibilities such as participation in extracurricular activities at school and employment outside of the home. Health-care professionals should take the time to assess not just what adolescents eat, but also the contextual factors that affect how and why they make specific food choices.

Snacking

Adolescents lead busy lives. Many are involved in extracurricular sports or academic activities, others are employed, and many must care for younger children in a family for part of the day. These activities, combined with the increased need for social contact and approval, and increasing academic demands as they proceed through school, leave little time for adolescents to sit down to eat a meal. Snacking, skipping meals, and eating foods that are cheap and quick, such as vending machine snacks and fast foods, are commonplace behaviors among adolescents who report a lack of time as a major barrier to healthy eating.

A survey of adolescent snacking suggest they consume 4.3 snacks per day, with 2.2 of these snacks consisting of energy-dense foods.[15] Snacks were purchased away from home on 3.2 occasions each week. Factors associated with higher frequency of snacking include self-identifying as a picky eater, frequent involvement in cooking at home, attempting to gain weight, snacking while watching television, and amount of time spent playing video games.[15,16] Factors associated with lower snack consumption were attempting to lose weight, concern over weight, dieting, and greater nightly sleeping time.[15,16] Frequent snacking is associated with higher energy, sugar-sweetened beverage, and fast-food intakes as well as lower fruit and vegetable intake.[15,16] Eating patterns that consist of frequent snacking result in a higher total energy intake and greater proportion of calories from added and total sugars. Snacks account for approximately one-quarter of daily food energy among adolescents, with 23 percent of total fat, and 36 percent of added sugars provided by snacks alone.[17] Foods and beverages consumed during snacking contribute significantly to daily nutrient intake however, providing 24 percent of fiber, 14 percent of protein, 17 percent of folate, 32 percent of vitamin C, 19 percent of vitamin D, 23 percent of calcium, 25 percent of magnesium, 22 percent of potassium, and 19 percent of iron.[17]

Unfortunately, the food choices made by adolescents while snacking tend to favor foods high in added sugar, sodium, and fat. Sweetened beverages are a commonly chosen snack for adolescents, consumed by half of teens each day.[18,19] They provide approximately 6 percent of daily energy for teens.[20] Intake of sugar-sweetened beverages has declined in the past 20 years, with a 23 percent decline in contribution of total sugar and a 30 percent decline in contribution to daily energy intake over that time.[20] Sugar-sweetened beverage consumption is more common among non-Hispanic Black youth than non-Hispanic Asian and non-Hispanic White youth. The 2019 Youth Risk Behavior Surveillance (YRBS) reported that 18 percent of male adolescents and 12 percent of female adolescents consumed at least one soda per day; these levels of consumption are significantly lower than consumption reported a decade earlier.[20] Sports drinks were consumed by 14 percent of male adolescents and 7 percent of female students in 2019, which is also lower than levels reported a decade before.[20] Other beverage snack choices that may contribute to daily energy and added sugar intakes include fruit drinks, sweetened plant-based milk alternatives (e.g., almond milk), and sweetened coffee or tea drinks.

Snack foods that are significant sources of energy, fat, and sugars in the diets of teenagers include dairy desserts, salty snacks, pizza, and sweet baked goods and pastries.[19] Health practitioners working with adolescents need to understand that snacking is a commonplace behavior among adolescents and should work with adolescents to improve food choices rather than discouraging snacking. Due to the frequency of snacking, an improvement in food choices during snacking toward more nutrient-dense foods has the potential to significantly impact the dietary intake and adequacy of adolescents. Although increased frequency of snacking among teens is associated with greater energy intakes, it is not clear that a greater frequency of snacking among adolescents leads to higher BMI values.[15] This may be due to teens choosing less energy dense snacks or to snacks replacing meals rather than being eaten in addition to meals.

Meal Skipping

The occurrence of meal skipping increases as adolescents mature. Meals may be missed for a variety of reasons including lack of time to eat, lack of food available to eat, and weight concerns. Breakfast is the most commonly skipped meal, with less than 73 percent of teens eating breakfast on a given day, and 17 percent of students skipping breakfast every day.[20,21] Breakfast skipping is more common among youths from low-income households and among non-Hispanic Black teens.[21] Skipping breakfast can decrease intakes of energy, protein, fiber, calcium, and

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folate due to the absence of fortified breakfast cereal with milk or other nutrient-dense foods commonly consumed at breakfast. Research suggests that students who consume school breakfast every day had higher intakes of dairy foods, fruit, vegetables, and legumes along with higher intakes of calcium, fiber, and whole grains.[22]

Lunch is skipped by 17 percent of adolescents, with the rates higher among females than males.[22,23] More teens skip lunch on weekends than on weekdays, particularly among non-Hispanic Black youths; 30 percent missed lunch on weekends.[22,23] Skipping lunch has been found to reduce intakes of vitamin K, calcium, magnesium, vitamin D, and potassium among all adolescents, as well as vitamin A and phosphorous among female adolescents, and vitamin C among male adolescents.[23] Teens who report eating lunch daily consume more dairy foods and calcium.

Eating Away from Home and Family Meals

Eating away from home becomes prevalent during adolescence. More than one-third of daily energy, protein, and carbohydrate intakes are consumed away from home each day, along with 35 percent of total fat and sugar intake.[24,25] Common sources of foods eaten away from home include school meals, vending machines, school canteens and stores, fast-food restaurants, and convenience or corner stores. Analysis of empty calories as a component of total energy intake among U.S. youth suggests that stores (33 percent), school food sources (32 percent), and fast-food restaurants (35 percent) contribute similarly to nutrient profiles of youth.[24,25] Food purchased in stores provided more energy from sugar (15 percent) than those from schools and fast-food outlets (10 percent for both) while fast food provided more energy from solid fats (24 percent) than food from schools (22 percent) or stores (18 percent).

School meals program, including the National School Lunch (NSLP) and Breakfast (NSB) Programs, are a significant source of food and nutrient intake for adolescents outside of the home. Youths from food-insecure households obtain about 25 percent of their daily energy intake from school meals, compared to 16 percent for youths from food-secure households.[26] An evaluation of lunches consumed by youths from the NSLP and lunches from home or other sources found that HEI scores for NSLP participants were considerably higher (HEI = 80 vs. HEI = 66). NSLP participants were more likely to meet recommendations for intakes of dairy and whole grains (higher intakes) and refined grains and empty kcals (lower intakes).[27]

As adolescents spend more time with peers, participation in family meals tends to decline. Most adolescents report eating meals with their family three or more times per week, with around half of adolescents eating meals with their families at least five times per week.[28] More frequent family meals are associated with improved dietary intake among adolescents, including higher intakes of fruits, vegetables, and foods that are good sources of calcium, and decreased intake of soft drinks.[29] Family meals can promote long-term healthy eating habits as parents have the opportunity to model healthy eating attitudes and introduce teens to a wide variety of foods, behaviors that may track into adulthood.[29] Teens who participate in family meals at least 6 days per week are less likely to utilize substances such as alcohol and street drugs, are less likely to smoke, and experience better academic outcomes.[29] Similar improvements in dietary intake are found among older adolescents living away from their parents who eat meals with others compared to those who eat alone.[29]

Vegetarian Diets

The term *vegetarian* is used quite broadly and can consist of many different eating patterns. Table 14.2 lists the most common vegetarian diet patterns, along with the foods most commonly excluded. When teens report that they "are vegetarian," it's important for nutrition service providers to determine the specific type of dietary pattern adhered to in order to determine which nutrients may require special attention during education and counseling. The prevalence of vegetarianism among adolescents is small—approximately 5 percent of adolescents identify as vegetarian, which includes the 1 percent of female and 3 percent of males identifying as vegan.[30] Consuming vegetarian meals is more common however, with about one-third of teens report eating vegetarian meals weekly, half eating vegetarian meals outside the home and one-fifth eating vegan meals outside the home.[30] Adolescents eat vegetarian meals for a variety of reasons, including taste, health concerns, cultural or religious beliefs, moral (animal welfare) or environmental/sustainable food systems concerns, health beliefs, as a means to restrict calories and/or fat intake, and as a means of exerting independence by adopting eating behaviors that differ from those of their family.[30,31] Regardless of the reason for consuming vegetarian meals, the adolescent's diet should be thoroughly assessed for nutritional adequacy. As a rule, the more foods that are restricted as part of any dietary pattern including vegetarian and vegan patterns, the more likely that nutritional deficiencies may occur. Consultation with a Registered Dietitian/Nutritionist or other health professional may be warranted.

Table 14.2 Types of vegetarian diets and foods excluded

Type of Vegetarian Diet	Foods Excluded
Lacto-ovo-vegetarian	Meat, poultry, fish, seafood
Lacto-vegetarian	Meat, poultry, fish, seafood, eggs
Vegan (total vegetarian)	Meat, poultry, fish, seafood, eggs, dairy products (may exclude honey)

Source: Adapted from Stang, J., & Story, M. (Eds.). *Nutrition and the Pregnant Adolescent: A Practical Reference Guide*. Minneapolis. MN: Center for Leadership, Education, and Training in Maternal and Child Nutrition, University of Minnesota, 2010.

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Case Study 14.1 Moral and Ethical Dietary Considerations Leading to Changes in Dietary Habits in Late Adolescence

Devonis is an 18-year-old male adolescent who is in his first year of undergraduate education at the state university. He hasn't yet declared a major but is leaning toward a dual degree in business and environmental studies. Devon lives in a residence hall on campus, where he has a 12-meal-per-week meal plan. He usually skips breakfast because he doesn't get up early enough to get to the cafeteria before his 9 a.m. class. He does stop at a coffee shop on his way to class several times per week, where he usually orders a macchiato or mocha coffee drink.

Devon eats lunch and dinner at the cafeteria most days of the week. He tends to focus on foods that are quick to eat, such as chicken sandwiches, pizza, French fries, chicken fingers, and burgers. Occasionally, he will focus on the salad bar or sandwich bar, but often doesn't feel he has the time to do this. On weekends, he usually eats brunch late in the morning, snacking the rest of the day. Devon does have a mini-fridge and microwave in his dorm room, which he shares with a roommate. He keeps nonperishable foods in his room such as chips, cookies, instant noodle soup, and microwave popcorn; the mini-fridge is mostly used to store soft drinks and sports drinks. There are no grocery stores on campus so he buys his food and beverages at either the big-box pharmacy chain store or the convenience store close to his residence hall.

Questions

1. What food choices might you recommend to Devon to improve his weekend food intake? Specifically, what foods and beverages might be available at the pharmacy or convenience store that would be more nutrient-dense diet?
2. What food groups seem to be lacking in Devon's diet, and what nutrients are likely to be consumed below recommended levels as a result?

Devon has an interest in sustainable food practices, so he joined an environmental justice group on campus. The group frequently discusses topics related to animal welfare and the impact of feedlots on climate change. Devon has decided to follow the lead of his fellow group members and become a vegetarian, eliminating red meat, poultry, and fish from his diet. Within 2 months of becoming a vegetarian, he decided to give up all animal protein, including eggs and dairy. He also avoids foods with high fructose corn syrup and preservatives when possible.

Questions

1. What type of diet did Devon originally adopt? What type of diet is he currently consuming?
2. What are nutrients are now of concern for Devon, given his biological age and recent adoption of a more restrictive diet?
3. What are potential health and nutrition benefits of Devon's dietary choices?
4. Is Devon's choice of diet developmentally normal? Is it likely to affect his growth?
5. What are food items that Devon can keep in his dorm room for weekend consumption, given his dietary beliefs?



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Adolescents who follow vegetarian diets have been found to be about the same height, of slightly lower weight, and to enter puberty at a later age than omnivores.[32] Effects of vegan diets on bone density among adolescents is not well defined, with some studies suggesting that dairy intake may increase bone mineral density.[32] Concerns over increased risk of bone fractures among vegan youths, particularly females, has been raised.

Vegetarian diets can offer health advantages to adolescents, such as a high intake of fiber, a lower intake of saturated fat, and relatively high intake of the vitamins and minerals found in plant-based foods. Data suggest that vegetarian adolescents consume more fruits, vegetables, legumes and nuts or soy products, and drank fewer sugar-sweetened beverages and less coffee and tea than omnivorous peers.[33] As a result, they consumed more carbohydrates and total protein along with less saturated fat and zinc compared to omnivorous teens.[33] Careful attention must be paid to ensure adequate intakes of calcium; zinc; iron; long-chain *n*-3 fatty acids; and vitamins D, B_6, and B_{12}, particularly among teens who frequently choose vegan meals. Supplements of vitamins B_{12} and D, iron, zinc, and calcium are often recommended for vegan youths unless fortified foods are routinely consumed. It has been suggested that more than half of vegans take nutrient supplements.[32] Fortification and nutrient contents of foods can vary widely among food brands, particularly for foods commonly consumed in vegetarian meals such as plant-based milk and meat

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Table 14.3 Suggested daily food guide for lacto-ovo and vegan vegetarians 11 years and older requiring 2,200–2,800 kcal per day

Food Groups	Lacto-Ovo Vegetarians	Vegan Vegetarians
Breads, grains, cereal	9–11	10–12
Legumes	2–3	3 or more
Vegetables	4–5	5 or more
Fruits	4	4 or more
Nuts, seeds	1	4–6
Milk, yogurt, cheese	4	—
Soy, almond, or rice milk (fortified with calcium and vitamin D)	—	4
Eggs	½–1	—

Sources: Data from E. H. Haddad (1994), "Development of a Vegetarian Food Guide," in *Am J Clin Nutr*, 59:307–316; and Story, M., et al. (Eds.), *Bright Futures in Practice: Nutrition*, National Center for Education in Maternal and Child Health, 2000.

substitutes; thus, label reading should be encouraged and taught. A suggested dietary food guide for adolescent vegetarians is listed in Table 14.3.

Physical Activity

Physical activity is defined as any bodily movement produced by skeletal muscles, which results in energy expenditure.[34] This definition is distinguished from exercise, which is a subset of physical activity that is planned, structured, and repetitive and is done to improve or maintain physical fitness. Physical fitness is a set of attributes that are either health- or skill-related. The Physical Activity Guidelines for Americans recommends that all adolescents engage in at least 60 minutes of moderate- to vigorous-intensity aerobic activity daily.[34] These guidelines also recommended that adolescents engage in muscle- and bone-strengthening activities at least 3 days per week.

Regular physical activity leads to many health benefits. It improves aerobic endurance and muscular strength, may reduce the risk of developing obesity, and builds bone mass density.[34] Physical activity among adolescents is consistently related to higher levels of self-esteem and self-concept and lower levels of anxiety and stress.[35] Thus, physical activity is associated with both physiological and psychological benefits, which offers opportunities to positively influence the adoption of lifelong activity patterns. Increasing physical activity among adolescents is an important goal because regular physical activity declines across the life span and many American teens are inactive.

Despite common knowledge about the importance and benefits of physical activity, only 23 percent of U.S. adolescents are active every day of the week, with half of teens reporting participating in exercises to strengthen muscles and only 17 percent meeting both requirements.[20] Adolescents identifying as male are twice as likely to meet each of the physical activity guidelines compared to those identifying as female. About half of females and 60 percent of males participate on a sports team but only about one in four have physical education classes every day.[20] Racial and ethnic differences are noted in physical activity; White teens are more likely to meet and Hispanic teens are least likely to meet daily aerobic physical activity targets, while Black students are least likely to meet combined aerobic and muscle-toning activity guidelines.[20]

While some youths enjoy competitive sports, others prefer less structured activity options. The American College of Sports Medicine recommends offering adolescents options for fun (rather than only competitive) physical activity that take into account individual differences in interest, capability, and skill levels.[35] Youths who have medical conditions or disabilities should have physical activity options tailored to their abilities and needs, with duration and frequency of physical activity gradually increasing.

14.4 Dietary Requirements, Intake, and Adequacy Among Adolescents

Energy and Nutrient Requirements of Adolescents

Increases in lean body mass, skeletal mass, and body fat that occur during puberty result in energy and nutrient needs that exceed those at any other point in life. Energy and nutrient requirements of adolescence correspond with the biological demands and degree of physical maturation that has taken place. Unfortunately, there is little available data that define optimal nutrient and energy intakes during adolescence. Most existing data are extrapolated from adult recommendations. Suggested intakes of energy, protein, and some other nutrients are often based on adequate growth as opposed to optimal physiological functioning. The Dietary Reference Intakes (DRIs) provide the best estimate of nutrient requirements for adolescents (Table 14.4).[36] It should be noted, however, that these nutrient recommendations are classified according to chronological age, as opposed to individual levels of biological development. Thus, health-care professionals must use prudent professional judgment based on SMR status, and not solely on chronological age, when determining the nutrient needs of an adolescent. In addition, nutritional needs are based on the physiological sex of an individual, as opposed to the sex they self-identify as, since the physiological differences in body composition and nutrients needs of menstruation will determine biological needs for specific nutrients. Food components and nutrients of particular concern for teens are discussed in greater detail in the following sections.

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Table 14.4 Dietary Reference Intakes of selected nutrients for adolescents

	Calcium (mg/d)	Phosphorus (mg/d)	Magnesium (mg/d)	Vitamin D (iu/d)[a,b]	Fluoride (mg/d)	Thiamin (mg/d)	Riboflavin (mg/d)	Niacin (mg/d)c	Iron (mg/d)
Males									
9–13 years	1,300	**1,250**	**240**	600	2*	**0.9**	**0.9**	**12**	8
14–18 years	1,300	**1,250**	**410**	600	3*	**1.2**	**1.3**	**16**	11
Females									
9–13 years	1,300	**1,250**	**240**	600	2*	**0.9**	**0.9**	**12**	8
14–18 years	1,300	**1,250**	**360**	600	3*	**1.0**	**1.0**	**14**	15
Pregnancy									
≤18 years	1,300	**1,250**	**400**	600	3*	**1.4**	**1.4**	**18**	27
Lactation									
≤18 years	1,300	**1,250**	**360**	600	3*	**1.4**	**1.6**	**17**	10
Life-Stage Group	**Vitamin B_6 (mg/d)**	**Folate, (mg/d)**	**Vitamin B_{12} (mg/d)**	**Pantothenic acid (mg/d)**	**Biotin (mg/d)**	**Choline (mg/d)[d]**	**Vitamin C (mg/d)**	**Vitamin E (mg/d)**	**Selenium (mg/d)**
Males									
9–13 years	1.0	**300**	**1.8**	4*	20*	375*	**45**	**11**	**40**
14–18 years	1.3	**400**	**2.4**	5*	25*	550*	**75**	**15**	**55**
Females									
9–13 years	1.0	**300**	**1.8**	4*	20*	375*	**45**	**11**	**40**
14–18 years	1.2	**400**	**2.4**	5*	25*	400*	**65**	**15**	**55**
Pregnancy									
≤18 years	1.9	**600**	**2.6**	6*	30*	450*	**80**	**15**	**60**
Lactation									
≤18 years	2.0	**500**	**2.8**	7*	35*	550*	**115**	**19**	**70**

NOTE: This table presents Recommended Dietary Allowances (RDAs) in bold type and Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). RDAs and AIs may both be used as goals for individual intake. RDAs are set to meet the needs of almost all (97–98 percent) individuals in a group. For healthy and breastfed infants, the AI is the mean intake. The AI for other life stage and gender groups is believed to cover needs of all individuals in the group, but lack of data or uncertainty in the data prevent being able to specify with confidence the percentage of individuals covered by this intake.

[a] As cholecalciferol. 1 mg cholecalciferol = 40 IU vitamin D.

[b] In the absence of adequate exposure to sunlight.

[c] As niacin equivalents (NE). 1 mg of niacin = 60 mg tryptophan; 0–6 months = preformed niacin (not NE).

[d] Although AIs have been set for choline, there are few data to assess whether a dietary supplement of choline is needed at all stages of the life cycle, and it may be that the choline requirement can be met by endogenous synthesis at some of these stages.

Source: Adapted from Dietary Reference Intakes: Recommended Intakes for Individuals, National Academy of Sciences.

Energy

Energy needs of adolescents are influenced by physical activity level, basal metabolic rate (BMR), body composition, and increased requirements to support pubertal growth and development. BMR is closely associated with the amount of lean body mass of individuals. Because male adolescents experience greater increases in height, weight, and lean body mass, they have significantly higher caloric requirements than do female adolescents. The estimated energy requirements for adolescents are listed in Table 14.5. Due to the great variability in the timing of growth and maturation among adolescents, the determination of energy needs based on velocity of growth will provide a better estimate than one based on chronological age.

The DRI for energy is based on the assumption of an inactive level or low to very active levels. Therefore, adolescents who participate in competitive sports and those who are more active than average may require additional energy to meet their individual needs. Conversely, adolescents who are inactive or those who have chronic conditions that limit their mobility will require less energy to meet their needs (Table 14.6).

Physical growth and development during puberty is sensitive to energy and nutrient intakes. When energy intakes fail to meet requirements, linear growth may be impeded and sexual maturation may be delayed. The standard way to gauge adequacy of energy intake is to assess height, weight, and body composition. If, over time, height as

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Table 14.5 Recommended intakes of macronutrients based on NAM Daily Recommended Intakes

	Estimated Energy	Carbohydrate (g)	% of Daily Energy from Carbohydrate	Fiber (g)	% of Daily Energy from Fat	Linoleic Acid A (g)	Alpha-linolenic Acid (g)	Protein (g) from Protein	% Energy Requirements
Males									
9–13	2,279	130	45–65	31	25–35	12	1.2	34	10–30
14–18	3,152	130	45–65	38	25–35	16	1.6	52	10–30
Females									
9–13	2,071	130	45–65	26	25–35	10	1.0	34	10–30
14–18	2,368	130	45–65	26	25–35	11	1.1	46	10–30

Table 14.6 Estimated Energy Requirements (EER) equations by age, sex, physical activity, and energy cost of growth in adolescents 14 years and above with sample calculation

Age Group	Sex	PAL Category	EER Equation (kcal/day)
14 to 18.99 years	M	Inactive	EER = −447.51 + (3.68 × age) + (13.01 × height) + (13.15 × weight) + 20
		Low active	EER = 19.12 + (3.68 × age) + (8.62 × height) + (20.28 × weight) + 20
		Active	EER = −388.19 + (3.68 × age) + (12.66 × height) + (20.46 × weight) + 20
		Very active	EER = −671.75 + (3.68 × age) + (15.38 × height) + (23.25 × weight) + 20
	F	Inactive	EER = 55.59 − (22.25 × age) + (8.43 × height) + (17.07 × weight) + 20
		Low active	EER = −297.54 − (22.25 × age) + (12.77 × height) + (14.73 × weight) + 20
		Active	EER = −189.55 − (22.25 × age) + (11.74 × height) + (18.34 × weight) + 20
		Very active	EER = −709.59 − (22.25 × age) + (18.22 × height) + (14.25 × weight) + 20

NOTES: kcal/d = kilocalories per day; PAL = physical activity level; EER = Estimated Energy Requirement. Age is in years, weight is in kilograms, and height is in centimeters.

Source: National Academies of Sciences, Engineering, and Medicine. *Dietary Reference Intakes for Energy*. Washington, DC: The National Academies Press, 2023. doi: https://doi.org/10.17226/26818.

well as weight-for-height or body mass index (BMI) continuously fall within the same percentiles when plotted on gender-appropriate National Center for Health Statistics growth charts, it can be assumed that energy needs are being met. If percentile of weight-for-height or BMI measurements begins to fall or rise, a thorough assessment of energy intake should be done, and adjustments in energy intake should be made accordingly. The use of body-fat measurements, such as triceps and subscapular skinfold measurements, can provide useful information when weight-for-height does not remain consistent. Remember, however, that transient increases and decreases in body fat are commonly noted among adolescents during puberty due to the variation in timing of increases in height, weight, and accumulation of body fat and lean body mass. Repeated measurements of weight, height, and body composition over a several-month period are needed to accurately assess adequacy of growth and development trajectories.

Protein

Protein needs of adolescents are influenced by the amount of protein required for maintenance of existing lean body mass, plus allowances for the amount required to accrue additional lean body mass during the adolescent growth spurt. The estimated protein need for adolescents is 0.85 g/kg body weight per day, slightly higher than that of adults.[36] Because protein needs vary with the degree of growth and development, requirements based on developmental age will be more accurate than absolute recommendations based on chronological age.

Recommended protein intakes are shown in Table 14.5. Protein requirements are usually highest for female adolescents at 11–14 years and for male adolescents at 15–18 years, when growth is at its peak. Similar to energy needs, estimation of protein needs based on timing of growth or SMR rather than chronological age is most accurate. As with energy, growth is affected by protein intakes. Subgroups of adolescents may be at risk for low protein intakes, including those from food-insecure households and those who restrict food intake for weight loss. It should be noted that daily protein food intake decreased significantly between the 2003–2004 and 2015–2016 NHANES cycles, with female adolescents consuming protein foods below recommended levels.[37] Thus, nutrition assessments conducted with female adolescents should specifically examine intake of both animal- and plant-based protein sources.

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Carbohydrates

Carbohydrates provide the body's primary source of dietary energy. Carbohydrate-rich foods such as fruit, vegetables, whole grains, and legumes are also the main source of dietary fiber. The recommended intake of carbohydrate among teens is 130 g per day, or 45–65 percent of daily energy needs (Table 14.5).[36] Male adolescents consume an average of 21 tsp of added sugars per day, with a range of 6 to 45 tsp/day.[37] Female adolescents consume an average of 17 tsp of added sugars each day, with a range of 5 to 34 tsp/day.[37] Less than one-quarter of adolescents meet the DGA recommendations for added sugars. There are significant racial and ethnic differences in added sugar intake, with Asian youths more likely to meet the DGA recommendation for added sugars, followed by Hispanic, White, and Black youths. Socioeconomic status does not appear to significantly influence whether or not youths meet the DGA recommendation for added sugars.[37] Soft drinks, candy, baked goods, and sweetened beverages (such as sports drinks and energy drinks) are major sources of added sweeteners in the diets of adolescents.

Dietary Fiber

Dietary fiber is important for normal bowel function and may play a role in the prevention of chronic diseases such as certain cancers, coronary artery disease, and type 2 diabetes mellitus. Adequate fiber intake is also thought to reduce serum cholesterol levels, moderate blood sugar levels, and reduce the risk of obesity. The DRIs set the recommended intake of dietary fiber for female adolescents at 26 g per day, for male adolescents < 14 years of age at 31 g per day, and for older male adolescents at 38 g per day.[36] National data indicate that male adolescents consume 15.7 g of fiber per day, while female adolescents consume 13.5 g per day.[38] This is well short of DRI recommendations.[36] A low intake of fruits, vegetables, nuts, seeds, soy products, legumes and whole grains are contributing factors affecting fiber intake among adolescents.[37]

Fat

The human body requires dietary fat and essential fatty acids for normal growth and development. Current recommendations suggest that children over the age of 2 years consume no more than 25–35 percent of calories from fat, with no more than 10 percent of calories derived from saturated fat.[36,37] Data on energy and macronutrient intakes among adolescents suggest that approximately 35 percent of total calories consumed are derived from fat, with 12 percent coming from saturated fats.[38] The DRIs recommend specific intake of linoleic and alpha-linolenic acid to support optimal growth and development (Table 14.5).[36]

Calcium

Achieving an adequate intake of calcium during adolescence is crucial to physical growth and development. Calcium is the main constituent of bone mass. Because about half of peak bone mass is accrued during adolescence, calcium intake may be of great importance for the development of dense bone mass and the reduction of the lifetime risk of fractures and osteoporosis.[7] Additionally, calcium needs and absorption rates are higher during adolescence than any other time except infancy.[7,36,39] About half of bone mass during adolescence, with about a quarter of bone mass developed within 2 years of peak height velocity. Peak bone mineral capability occurs around 12.5 years of age for youth who are biologically female and 14 years of age for those who are biologically male.[39] Around 90 percent of bone mass is accrued by age 18 years.

The DRI for calcium for 9- to 18-year-olds is 1,300 mg per day (Table 14.4).[36] National data suggest that many adolescents, most notably females, do not consume the DRI for calcium. Adolescent females consume 813 mg calcium per day, while adolescent males have been found to consume about 1,079 mg calcium each day.[38] The level of dietary intake among females is not adequate to support the development of optimal bone mass. Dairy intake (which includes soy-based alternatives) among adolescents has declined over the past decades, resulting in lower calcium intakes in this age group.[37] While dietary sources of calcium are the preferred source, supplements may be warranted for adolescents who do not consume adequate calcium from dietary sources, particularly those with lactose intolerance.[40]

Iron

The rapid rate of linear growth, the increase in blood volume, and the onset of menarche among female adolescents during adolescence increase a teen's need for iron. The DRIs for iron for male and female adolescents are shown in Table 14.4.[36] These recommendations are based on the amount of dietary iron intake needed to maintain a suitable level of iron storage, with additional amounts of iron added to cover the rapid linear growth and onset of menstruation that occur in biologically male and female adolescents, respectively. Note that even though DRIs are based on chronological age, actual iron requirements of adolescents should be based on sexual maturation level. Iron needs of an adolescent will be highest during the adolescent growth spurt in male adolescents, and after menarche in female adolescents.

The age-specific hemoglobin and hematocrit values used to determine iron-deficiency anemia are listed in Table 14.7. Hemoglobin and hematocrit levels, although commonly used to screen for the presence of iron-deficiency anemia, are actually the last serum indicators of depleted iron stores to drop. More sensitive indicators of iron stores include **serum iron, plasma ferritin, and transferrin saturation**. These measures are expensive and not commonly used in routine medical visits, however. Dietary intakes of iron are estimated

serum iron, plasma ferritin, and transferrin saturation Measures of iron status obtained from blood plasma or serum samples.

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Table 14.7 Common biochemical indices

	Ideal	Borderline Acceptable	Unacceptable
Total cholesterol (mg/dL)	<170	170–199	≥200
LDL cholesterol (mg/dL)	<110	110–129	≥130
Non-HDL cholesterol (mg/dL)	<120	120–144	≥145
HDL cholesterol (mg/dL)	>45	40–45	<40
Triglycerides (mg/dL)	<90	90–129	≥130
Apolipoprotein A-1	>120	115–120	≥115
Apolipoprotein B	<90	90–109	≥110
Hemoglobin (g/dL)	Males ≥12.5 (12–15 years) ≥13.3 (16–18 years) ≥13.5 (18+ years) Females ≥11.8 (12–15 years) ≥12.0 (16+ years)		
Hematocrit (%)	Males ≥37.3 (12–15 years) ≥39.7 (16–18 years) ≥39.9 (18+ years) Females ≥35.7 (12–15, 18+ years) ≥35.9 (16–18 years)		

at 15.5 mg day among 12- to 19-year-old male adolescents and 12.2 mg per day among 12- to 19-year-old female adolescents.[38]

Estimates of iron deficiency among adolescents are 9 percent of 12- to 15-year-old female adolescents, 5 percent of 12- to 16-year-old male adolescents, 11 percent of 15- to 19-year-old female adolescents, and 2 percent of 15- to 19-year-old male adolescents.[41] Rates of iron deficiency and anemia are twice as high among Black and Mexican American female adolescents compared to White female adolescents and among adolescents from low-income families.[41] Iron deficiency and iron-deficiency anemia are affected by food security status, which generally correlates with family income. National data collected between 1999 and 2004 suggest that iron deficiency occurs in 8.4 percent of adolescents from food-secure households while it is identified in 10.8 percent of adolescents from food-insecure households.[42] Similarly, iron-deficiency anemia has been estimated to affect 1.4 percent of teens from food-secure households and 2.3 percent of teens from food-insecure households.[42] These results were noted despite the fact that iron intake was similar among the groups.

Vitamin D

Vitamin D is a fat-soluble vitamin that plays an essential role in facilitating intestinal absorption of calcium and phosphorus that is required to maintain adequate serum levels of these minerals.[36] Vitamin D can be synthesized by the body through exposure of skin to ultraviolet B rays of sunlight. However, individuals who live in northern latitudes may not receive adequate exposure to sunlight in the winter months to facilitate synthesis of adequate amounts of vitamin D.[43] Individuals with dark skin pigmentation may also experience limited vitamin D production by the body.[43,44]

Adequate vitamin D status has long been known as essential for optimal bone formation.[39,40] Low levels of vitamin D among adolescents have been found to be inversely related to systolic blood pressure, fasting plasma glucose levels, hypertriglyceridemia, and metabolic syndrome.[45] Low vitamin D status is also associated with low HDL cholesterol levels and higher BMI and abdominal obesity measurements. There has been controversy regarding a single, consistent set of cut-points for vitamin D status. The National Academy of Medicine cut-points for vitamin D status include: at risk of deficiency = serum 25(OH) D < 30 nmol/L (< 12 ng/mL); at risk of inadequacy = serum 25(OH)D 30–49 nmol/L (12–19 ng/mL); sufficiency = serum 25(OH)D 50–125 nmol/L (20–50 ng/mL); and possible concern = serum 25(OH)D > 125 nmol/L (> 50 ng/mL).[46] Using these referent values, the prevalence of U.S. adolescents at risk for deficiency is estimated at 4.8 percent, with 22.7 percent being at risk of inadequacy.[47] Risk of deficiency and inadequacy was highest among non-Hispanic Black youths followed by non-Hispanic Asian, Hispanic, and White Americans.

Average dietary intakes from foods and beverages are estimated at 4.9 μg, which is far below the requirement of 15 μg.[46] Supplementation may be required for those at risk of low vitamin D status, including teens who routine cover most skin when outdoors, do not routinely consume fortified foods such as dairy products, and those with darkly pigmented skin. The Society of Adolescent Health and Medicine has recommended vitamin D supplementation of 600 IU daily for all adolescents, with at least 1,000 IU daily for adolescents who are at risk of vitamin D deficiency or insufficiency.[48]

Dietary Intake and Nutritional Adequacy

Dietary surveys of U.S. adolescents suggest that many consume inadequate amounts of vitamins and minerals; this trend is more pronounced in female teens than in male teens; however, most adolescents do not consume diets that comply with the Dietary Guidelines for Americans.[37] Food components and nutrients of public health concern among adolescents include fiber, calcium, phosphorous, magnesium, vitamin D, and choline. Nutrients of public health concern among adolescents who are biologically female also include protein, iron, folate and vitamins B_6 and B_{12}.[37] The vast majority of adolescents consume diets that exceed current

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recommendations for total and saturated fats, cholesterol, sodium, and added sugar; these food components are all considered risk factors for chronic disease and obesity.[37]

Few adolescents meet recommendations for fruit or vegetable consumption. Nationally representative data suggest that less than 5 percent of male adolescents and less than 8 percent of female adolescents met recommendations for fruit intake, while 2 percent of male adolescents and 1 percent of female adolescents met recommendations for total vegetable intake.[37] According to the YRBS, 41 percent of male and 43 percent of female teens reported consuming fruit less than once per day while 41 percent of male teens and 40 percent of female teens consuming less than one serving of vegetables on a given day.[20] Inadequate intakes of both fruit and vegetables were higher among Black students than White or Hispanic students and are lowest among Asian teens.[20,37] Intakes of dark green and red/orange vegetables are particularly low, as are intakes of legumes.[37]

Adequate intake of servings of grains are reported by the majority of teens; however, intake of whole grains is far below recommended levels.[37] While whole grain intake is still lower than the recommended 50 percent of total grain intake, it has risen over the past two decades. The average intake of total protein foods, including meat, poultry, seafood, and meat alternatives generally within the recommended range for many adolescents; however, female adolescent intake of protein foods has decreased in the past decade and is below recommended levels.[37] Intakes of seafood, eggs, and legumes are particularly low, which may contribute to inadequate intakes of choline, fiber, vitamin D, and some fatty acids. Intake of dairy products, which includes soy-based dairy alternatives but does not include other plant-based dairy alternatives, is especially low among adolescents, with 79 percent reporting less than adequate intake.[37] Low dairy consumption is more common among female teens than among male teens.

14.5 Nutrition Screening, Assessment, and Intervention

Dietary Assessment and Screening

Annual screening of all adolescents for indicators of nutritional risk is recommended. Common concerns that should be investigated during nutrition screening include overweight, underweight, eating disorders, hyperlipidemia, hypertension, iron deficiency and/or anemia, food insecurity, and excessive intake of foods and/or beverages high in solid fast and added sugars foods (Table 14.8).

Nutrition screening should include an accurate measurement of height and weight, and calculation of body mass index (BMI). These data, plotted on age- and gender-appropriate National Center for Health Statistics 2000 growth charts, indicate the presence of any weight or other growth problems. Table 14.9 shows the percentile range for each weight status category, as well as an example of BMI-for-age percentiles for an adolescent boy. Teens below the 5th percentile of weight-for-height or BMI-for-age are considered to be underweight and should be referred for evaluation of metabolic disorders, chronic health conditions, or eating disorders.[49]

Table 14.8 Recommended health assessment and screening for prevention of chronic disease and promotion of optimal health

Health Issue	Young Adolescent (12–17 y.o.)	Older Adolescent (18–21 y.o.)
Dietary behaviors	• Assess usual food intake using age-appropriate method. • Provide appropriate nutrition intervention and/or medical nutrition therapy as needed.	• Assess usual food intake using age-appropriate method. • Provide appropriate nutrition intervention and/or medical nutrition therapy as needed.
Physical activity and sedentary activity	• Review usual daily physical and sedentary behavior patterns. • Discuss recommendation for 60 minutes or more of moderate-to-vigorous physical activity per day. • Emphasize importance of limiting sedentary activity, with no more than 2 hours of screen time per day.	• Review usual physical and sedentary behavior patterns with client. • Discuss recommendation for 60 minutes or more of moderate-to-vigorous physical activity each day. • Emphasize importance of limiting sedentary activity and recommend no more than 2 hours of screen time per day.
Anthropometric measurements	• Assess and plot height, weight and BMI using appropriate methods. • Review weight status with adolescent and parent(s). • Refer adolescents experiencing obesity to a weight management program for Step 1 counseling (Chapter 15) and schedule follow-up appointment. • Refer obese adolescents to a comprehensive weight management program for Step 2 counseling.	• Assess and plot height, weight and BMI using appropriate methods. • Review weight status with client. • Thoroughly assess dietary intake and physical activity and sedentary activity behaviors and provide appropriate counseling for clients who are overweight and/or obese. • Refer clients who are overweight or obese to a primary health-care provider for full medical assessment and treatment.

(continued)

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Table 14.8 Recommended health assessment and screening for prevention of chronic disease and promotion of optimal health (continued)

Health Issue	Young Adolescent (12–17 y.o.)	Older Adolescent (18–21 y.o.)
Family history of premature cardiovascular disease, diabetes, and obesity	• Update family history at each visit. • Provide primary care referral and preventive dietary counseling based on family history as necessary.	• Update family history annually. • Provide primary care referral and preventive dietary counseling based on family history as necessary.
Blood pressure	• Interpret and review blood pressure readings with adolescent. • Counseling adolescents and caregivers on the DASH diet. • Request follow-up visit. • Assess changes in blood pressure at follow-up visit. Refer to primary care provider for blood pressure management with medication as needed, if dietary changes have not successfully reduced blood pressure. • Refer to adolescent weight management program if overweight and/or obese.	• Interpret and review blood pressure readings with client. • Counseling client on the DASH diet. • Request follow-up visit. • Assess changes in blood pressure at follow-up visit. Refer to primary care provider for blood pressure management with medication as needed, if dietary changes have not successfully reduced blood pressure. • Refer clients who are overweight or obese to a weight management program or provide appropriate dietary counseling.
Blood lipids	• Interpret and review blood lipid levels with adolescent and caregiver. • Refer adolescent to primary care provider and request a blood lipid panel for adolescents who are overweight or obese if laboratory data are not available. • Provide medical nutrition therapy as appropriate, based on blood lipid levels. • Refer teens who are overweight to a weight management program for Step 1 weight management or provide appropriate counseling (Chapter 15). • Refer teens experiencing obesity to a comprehensive weight management program. • Up to 2 g per day of plant sterols or stanols can be recommended for use by adolescents. • Refer to primary care provider for management of dyslipidemia including medication if dietary changes are not effective.	• Interpret and review blood lipid levels with client. • Refer client to primary care provider and request a blood lipid panel for adolescents who are overweight or obese if laboratory data are not available. • Provide medical nutrition therapy as appropriate, based on blood lipid levels. • Refer to a weight management program or provide appropriate counseling to promote weight loss if client is overweight or obese. • Up to 2 g per day of plant sterols or stanols can be recommended for use by adolescents. • Refer to primary care provider for management of dyslipidemia including medication if dietary changes are not effective.
Diabetes	• Assess for family history of diabetes, presence of acanthosis nigricans, and symptoms consistent with diabetes among adolescents who are overweight or obese. • Review fasting blood glucose levels with teens and caregivers or refer to primary care provider for treatment and drawing of a fasting blood glucose level if laboratory data are not available. • Provide medical nutrition therapy and nutrition counseling as appropriate. • Refer teens who are overweight and obese to a comprehensive weight management program.	• Assess for family history of diabetes, presence of acanthosis nigricans, and symptoms consistent with diabetes among clients who overweight or obese. • Review fasting blood glucose levels with clients or refer to primary care provider for treatment and drawing of a fasting blood glucose level if laboratory data are not available. • Provide medical nutrition therapy and nutrition counseling as appropriate. • Provide weight management counseling to clients who are overweight and obese.

Source: Adapted from U.S. Department of Health and Human Services, National Institutes of Health, National Heart, Lung and Blood Institute. Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents. Summary report. NIH Publication No 12-7486A, October 2012.

Table 14.9 Example of height and weight status for adolescents

Weight Status Category	Percentile Range
Underweight	Less than the 5th percentile
Healthy weight	5th percentile to less than the 85th percentile
Overweight	85th to less than the 95th percentile
Obese	Equal to or greater than the 95th percentile

Adolescents with a BMI above the 85th percentile but below the 95th percentile are considered to be overweight.[49] They should be evaluated to determine the presence or absence of obesity-related comorbid complications and referred for treatment as necessary. Teenagers with a BMI greater than the 95th percentile are considered to be obese and should be referred for a full medical evaluation.[49] Referral to a weight-management program specially designed to meet the needs of adolescents may also be warranted for overweight adolescents who have

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completed physical growth (refer to Chapter 15 for additional information).

Nutrition screening should include at least a brief dietary assessment. Food frequency questionnaires, 24-hour recalls, and food diaries or food records are all appropriate for use with adolescents. Table 14.10 lists the advantages and disadvantages of each dietary assessment method. Less formal dietary assessment questionnaires that target specific behaviors, such as consumption of savory snacks and sugar-sweetened beverages, can also be used for initial nutrition screening. These rapid-assessment questionnaires and screening tools can be completed quickly and may be used to identify those adolescents in need of additional dietary assessment and nutrition counseling. Online dietary assessments tools such as the ASA24 may be used with teens during nutrition assessment and counseling sessions or by teens on their own for self-assessment of dietary intake.[50]

Nutrition risk indicators that may warrant further nutrition assessment and counseling are listed in Table 14.11. Adolescents who have a poor-quality diet characterized by an excessive intake of high-fat or high-sugar foods and beverages or meal skipping should be provided with nutrition counseling that provides concrete examples of ways to improve dietary intake. Adolescents who have been found to have a nutrition-related health risk, such as hyperlipidemia, hypertension, iron-deficiency anemia, overweight, or an eating disorder, should be referred for in-depth medical assessment and nutrition counseling.

Adolescents who have food allergies or intolerances, or who consume vegan diets should be assessed for adequacy of vitamin and mineral intakes, specifically for nutrients that are commonly found in any excluding foods or food categories. Teens who consume a vegetarian diet, particularly if they report doing so for health- or weight-related reasons, should be carefully assessed for the presence of eating disorders, chronic dieting, and body-image disturbances. Surveys of adolescents have shown that those who consume vegetarian diets are somewhat more likely to report binge eating, almost twice as likely to report frequent or chronic dieting, four times more likely to report purging, and up to eight times more likely to report laxative use than nonvegetarian peers.[36] These results seem to reflect the fact that many individuals who are chronic dieters or who have disorder eating patterns adopt a vegetarian diet as a means of restricting fat intake or practicing self-denial rather than the vegetarian diet causing the restrictive behaviors. Adolescent vegetarians, especially male adolescents, have been found to be at high risk for engaging in unhealthy and often extreme weight-loss behaviors.[51] Therefore, it is imperative that practitioners working with adolescents who consume a vegetarian diet explore reasons for adopting this eating style and encourage adolescents to choose a wide variety of nutrient-dense foods.

Table 14.10 Strengths and limitations of various dietary assessment methods used in clinical settings

	Strengths	Limitations	Applications
24-hour recall	• Does not require literacy • Relatively low respondent burden • Data may be directly entered into a dietary analysis program • May be conducted in person or over the telephone	• Dependent on respondent's memory • Relies on self-reported information • Requires skilled staff • Time consuming • Single recall does not represent usual intake	• Appropriate for most people as it does not require literacy • Useful for the assessment of intake of a variety of nutrients and assessment of meal patterning and food group intake • Useful counseling tool
Food frequency	• Quick, easy, and affordable • May assess current as well as past diet • In a clinical setting, may be useful as a screening tool	• Does not provide valid estimates of absolute intake of individuals • Can't assess meal patterning • May not be appropriate for some population groups	• Does not provide valid estimates of absolute intake for individuals, thus of limited usefulness in clinical settings • May be useful as a screening tool; however, further development research is needed
Food record	• Does not rely on memory • Food portions may be measured at the time of consumption • Multiple days of records provide valid measure of intake for most nutrients	• Recording foods eaten may influence what is eaten • Requires literacy • Relies on self-reported information • Requires skilled staff • Time consuming	• Appropriate for literate and motivated population groups • Useful for the assessment of intake of a variety of nutrients and assessment of meal patterning and food group intake • Useful counseling tool
Diet history	• Able to assess usual intake in a single interview • Appropriate for most people	• Relies on memory • Time consuming (60–90 minutes) • Requires skilled interviewer	• Appropriate for most people, as it does not require literacy • Useful for assessing intake of nutrients, meal patterning, and food group intake • Useful counseling tool

Source: Used with permission. Story, M., & Stang, I. (Eds.). *Nutrition and the Pregnant Adolescent: A Practical Reference Guide*. Minneapolis, MN: Center for Leadership, Education, and Training in Maternal and Child Nutrition, University of Minnesota; 2000.

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Table 14.11 Key indicators of nutrition risk for adolescents

Indicators of Nutrition Risk	Relevance	Criteria for Further Screening and Assessment
FOOD CHOICES		
Consumes fewer than 2 servings fruit or fruit juice per day	Fruits and vegetables provide dietary fiber and several vitamins (such as A and C) and minerals. Low intake of fruits and vegetables is associated with an increased risk of many types of cancer. In females of childbearing age, low intake of folic acid is associated with an increase risk of giving birth to an infant with neural tube defects.	Assess the adolescent who is consuming less than 1 serving of fruit or fruit juice per day.
Consumes fewer than 3 servings of vegetables per day		Assess the adolescent who is consuming fewer than 2 servings of vegetables per day.
Consumes fewer than 6 servings of bread, cereal, pasta, rice, or other grains per day	Grain products provide complex carbohydrates.	Assess the adolescent who is consuming fewer than 3 servings of bread, cereal, pasta, rice, or other grains per day.
Consumes fewer than 3 servings of dairy products per day	Dairy products are a good source of protein, vitamins, and calcium and other minerals. Low intake of dairy products may reduce peak bone mass and contribute to later risk of osteoporosis.	Assess the adolescent who is consuming fewer than 2 servings of dairy products per day. Assess the adolescent who is consuming more than 20 oz of soft drinks per day.
Consumes fewer than 2 servings of meat or meat alternatives (e.g., beans, eggs, nuts, seeds) per day	Protein-rich foods (e.g., meats, beans, dairy products) are good sources of B vitamins, iron, and zinc. Low intake of protein-rich foods may impair growth and increase the risk of iron-deficiency anemia and of delayed growth and sexual maturation. Low intake of meat or meat alternatives may indicate inadequate availability of these foods at home. Special attention should be paid to children and adolescents who follow a vegetarian diet.	Assess the adolescent who is consuming fewer than 2 servings of meat or meat alternatives per day or who consumes a vegan diet.
Has excessive intake of dietary fat	Excessive intake of total fat contributes to the risk of cardiovascular diseases and obesity and is associated with some cancers.	Assess the adolescent who has a family history of premature cardiovascular disease. Assess the adolescent who has a BMI greater than or equal to the 85th percentile.
EATING BEHAVIORS		
Exhibits poor appetite	A poor appetite may indicate depression, emotional stress, chronic disease, or an eating disorder.	Assess the adolescent if BMI is less than the 15th percentile or if weight loss has occurred. Assess if irregular menses or amenorrhea have occurred for 3 months or more. Assess for organic and psychiatric disease.
Consumes food from fast-food restaurants three or more times per week	Excessive consumption of convenience foods and foods from fast-food restaurants is associated with high fat, calorie, and sodium intakes, as well as low intake of certain vitamins and minerals.	Assess the adolescent who is at risk for overweight/obesity, or who has diabetes mellitus, hyperlipidemia, or other conditions requiring reduction in dietary fat.
Skips breakfast, lunch, or dinner/supper three or more times per week Consumes a vegetarian diet	Meal skipping is associated with a low intake of energy and essential nutrients and, if it is a regular practice, could compromise growth and sexual development. Repeatedly skipping meals decreases the nutritional adequacy of the diet. Vegetarian diets can provide adequate nutrients and energy to support growth and development if well planned. Vegan diets may lack calcium, iron, and vitamins D and B_{12}. Low-fat vegetarian diets may be adopted by adolescents who have eating disorders.	Assess the adolescent to ensure that meal skipping is not due to inadequate food resources or unhealthy weight-loss practices. Assess the adolescent who consumes fewer than two servings of meat alternatives per day. Assess the adolescent who consumes fewer than three servings of dairy products per day. Assess the adolescent who follows a low-fat vegetarian diet and experiences weight loss for eating disorder and adequacy of energy intake.
Skips breakfast, lunch, or dinner/supper three or more times per week	Meal skipping is associated with a low intake of energy and essential nutrients and, if it is a regular practice, could compromise growth and sexual development. Repeatedly skipping meals decreases the nutritional adequacy of the diet.	Assess the adolescent to ensure that meal skipping is not due to inadequate food resources or unhealthy weight-loss practices.

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Table 14.11 Key indicators of nutrition risk for adolescents (continued)

Indicators of Nutrition Risk	Relevance	Criteria for Further Screening and Assessment
Consumes a vegetarian diet	Vegetarian diets can provide adequate nutrients and energy to support growth and development if well planned. Vegan diets may lack calcium, iron, and vitamins D and B_{12}. Low-fat vegetarian diets may be adopted by adolescents who have eating disorders.	Assess the adolescent who consumes fewer than two servings of meat alternatives per day. Assess the adolescent who consumes fewer than three servings of dairy products per day. Assess the adolescent who follows a low-fat vegetarian diet and experiences weight loss for eating disorder and adequacy of energy intake.
FOOD RESOURCES		
Has inadequate financial resources to buy food, insufficient access to food, or lack of access to cooking facilities	Poverty can result in hunger and compromised food quality and nutrition status. Inadequate dietary intake interferes with learning.	Assess the adolescent who is from a family with low income, is homeless, or is a runaway.
WEIGHT AND BODY IMAGE		
Practices unhealthy eating behaviors (e.g., chronic dieting, vomiting, and using laxatives, diuretics, or diet pills to lose weight)	Chronic dieting is associated with many health concerns (fatigue, impaired growth and sexual maturation, irritability, poor concentration, impulse to binge) and can lead to eating disorders. Frequent dieting in combination with purging is often associated with other health-compromising behaviors (substance use, suicidal behaviors). Purging is associated with serious medical complications.	Assess the adolescent for eating disorders. Assess for organic and psychiatric disease. Screen for distortion in body image and dysfunctional eating behavior, especially if adolescent desires weight loss, but BMI is < 85th percentile.
Is excessively concerned about body size or shape	Eating disorders are associated with significant health and psychological morbidity; 85% of all cases of eating disorders begin during adolescence. The earlier adolescents are treated, the better their long-term prognosis.	Assess the adolescent for distorted body image and dysfunctional eating behaviors, especially if adolescent wants to lose weight, but BMI is < 85th percentile.
Has exhibited significant weight change in past 6 months	Significant weight change during the past 6 months may indicate stress, depression, organic disease, or an eating disorder.	Assess the adolescent to determine the cause of weight loss or weight gain (limited to too much access to food, poor appetite, meal skipping, eating disorder).
PHYSICAL ACTIVITY		
Is physically inactive: engages in physical activity fewer than 5 days per week	Lack of regular physical activity is associated with overweight, fatigue, and poor muscle tone in the short term and a greater risk of heart disease in the long term. Regular physical activity reduces the risk of cardiovascular disease, hypertension, colon cancer, and type 2 diabetes mellitus. Weight-bearing physical activity is essential for normal skeletal development during adolescence. Regular physical activity is necessary for maintaining normal muscle strength, joint structure, and joint function; contributes to psychological health and well-being; and facilitates weight reduction and weight maintenance throughout life.	Assess how much time the adolescent spends watching television/videotapes and playing computer games. Assess the adolescent's definition of physical activity.
Engages in excessive physical activity	Excessive physical activity (nearly every day or more than once a day) can be unhealthy and associated with menstrual irregularity, excessive weight loss, and malnutrition.	Assess the adolescent for eating disorders.
MEDICAL CONDITIONS		
Has chronic diseases or conditions	Medical conditions (diabetes mellitus, spina bifida, renal disease, hypertension, pregnancy, HIV infection/AIDS) have significant nutritional implications.	Assess adolescent's compliance with therapeutic dietary recommendations. Refer to dietitian if appropriate.
Has hyperlipidemia	Hyperlipidemia is a major cause of atherosclerosis and cardiovascular disease in adults.	Refer adolescent to a dietitian for cardiovascular nutrition assessment.

(continued)

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Table 14.11 Key indicators of nutrition risk for adolescents (continued)

Indicators of Nutrition Risk	Relevance	Criteria for Further Screening and Assessment
Has iron-deficiency anemia	Iron deficiency causes developmental delays and behavioral disturbances. Another consequence is increased lead absorption.	Screen adolescents if they have low iron intake, a history of iron-deficiency anemia, limited access to food because of poverty or neglect, special health-care needs, or extensive menstrual or other blood losses. Screen annually.
Has dental caries	Eating habits have a direct impact on oral health. Calcium and vitamin D are vital for strong bones and teeth, and vitamin C is necessary for healthy gums. Frequent consumption of carbohydrate-rich foods (e.g., lollipops, soda) that stay in the mouth a long time may cause dental caries. Fluoride in water used for drinking and cooking as well as in toothpaste reduces the prevalence of dental caries.	Assess the adolescent's consumption of snacks and beverages that contain sugar, and assess snacking patterns. Assess the adolescent's access to fluoride (e.g., fluoridated water, fluoride tablets).
Is pregnant	Pregnancy increases the need for most nutrients.	Refer the adolescent to a dietitian for further assessment, education, and counseling as appropriate.
Is taking prescribed medication	Many medications interact with nutrients and can compromise nutrition status.	Assess potential interactions of prescription drugs (e.g., asthma medications, antibiotics) with nutrients.
LIFESTYLE		
Engages in heavy alcohol, tobacco, and other drug use	Alcohol, tobacco, and other drug use can adversely affect nutrient intake and nutrition status.	Assess the adolescent further for inadequate dietary intake of energy and nutrients.
Uses dietary supplements	Dietary supplements (e.g., vitamin and mineral preparations) can be healthy additions to a diet, especially for pregnant and lactating women and for people with a history of iron-deficiency anemia; however, frequent use or high doses can have serious side effects. Adolescents who use supplements to "bulk up" may be tempted to experiment with anabolic steroids. Herbal supplements for weight loss can cause tachycardia and other side effects. They may also interact with over-the-counter (OTC) prescription medications.	Assess the adolescent for the type of supplements used and dosages. Assess the adolescent for use of anabolic steroids and megadoses of other supplements.

Source: Adapted from Tool, D., from Holt, K. Wooldridge, N., Story, M. & Sofka, D. (Eds.). *Bright Futures: Nutrition,* 3rd ed. 2011.

In-depth nutrition assessment should include a review of the full medical history, a review of psychosocial and physical development, and evaluation of all laboratory data available. A complete and thorough dietary assessment should be performed, preferably using two dietary assessment methods. Most commonly, a food frequency questionnaire or a 3- to 7-day food record is combined with a 24-hour recall to provide accurate dietary intake data. Specific areas of nutrition concern can be identified during a complete nutrition assessment, and recommendations for nutrition education and counseling can be made accordingly.

Nutrition Education and Counseling

Providing nutrition education and counseling to teenagers requires a great deal of skill and a good understanding of normal adolescent physical and psychosocial development. Health professionals need to remember that developmentally, adolescents may look like young adults, but they are not. Their psychosocial development can vary tremendously, and they may not respond favorably to traditional adult counseling methods. It is also important to not provide nutrition education messages or materials that are too childish in nature. Adolescence is a unique developmental stage between young adulthood and childhood and requires its own approach to education and counseling. When working with teens, it is important to treat them as individuals with unique needs and concerns. This capitalizes on their developmental process of becoming autonomous and helps foster a sense of respect and self-reliance. Messages containing concrete recommendations (such as "choose foods with 5 g or less of fat per serving") and that incorporate activities or concerns from their daily lives will be most effective with teens. Such daily life activities and concerns might include improvements in academic achievement,

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clearer skin, shinier hair, improved athletic performance, or increased energy levels.

The initial component of the counseling session should involve getting to know the adolescent, including personal health or nutrition-related concerns. After establishing a rapport with the teen, the counselor should provide an overview of the events of the counseling session, including which specific nutrition topics will be discussed. Once again, the adolescent should be encouraged to add their own nutrition concerns to the list of topics to be discussed during the education session. After agreeing on a list of topic areas to be covered during the nutrition education session, a complete nutrition assessment should be performed. Upon completion of the assessment, the counselor and teen should work together to establish goals for improving dietary intake and reducing nutrition risk.

It is important to involve the adolescent in decision-making processes during nutrition counseling. Allowing teens to provide input as to what aspects of their eating habits they think need to be changed and what changes they are willing to make accomplishes several important tasks during the counseling session. First, the importance of the adolescent in the decision-making process is stressed, and teens are encouraged to become engaged in personal decisions about health. Second, a good rapport established between the health professional and the adolescent may lead to greater interaction between both parties. Finally, behavior change is more likely when the adolescent has suggested ways to change, thus becoming engaged in the education process and owning a willingness to change.

One or two goals during a counseling session are a reasonable number to work toward. Setting too many goals reduces the probability that the adolescent can meet all of the goals and may seem overwhelming. For each goal set, several potential behavior-change strategies should be mutually agreed upon for meeting that goal. These strategies should be concrete in nature and instigated by the teen. The adolescent and the counselor should also work together to decide how to determine when a goal is met. Meal planning and shopping tools, food goal apps and quizzes that support eating within the DGAs are available online (https://www.myplate.gov/resources/tools) and can be utilized by teens as they navigate making food choices. These tools can also help adolescents assess how changes in food choices affect changes in nutrient intake across time. Frequent follow-up sessions are helpful to provide feedback and monitor progress toward individual goals.

The use of technology to facilitate nutrition education and counseling for adolescents should be implemented whenever possible to engage adolescents and to provide nutrition information between client visits. Electronic communications methods such as text messaging, podcasts, YouTube videos, and social media posts are commonly accessed by adolescents and can serve as a means to convey nutrition information in a highly engaging way. Yet many health-care practitioners such as Registered Dietitians/Nutritionists are wary of promoting media-driven health education due to concerns over screen time exposure and privacy issues or because of a lack of skills in managing online content. A review of literature around the use of social media among youth for health promotion purposes suggests that social media can be a powerful tool for engaging teens in health promotion messages and activities.[52] Several national organizations have developed social media guidelines that can guide health-care practitioners in the use of integrating social media into health and nutrition education and counselling. The U.S. Substance Abuse and Mental Health Services Administration offers a wide variety of digital media resources for professionals, and the USDA's Nutrition.gov and myplate.gov websites contain information and tools to help you make healthful food choices, while the American Academy of Pediatrics provides a series of health-focused social media options for teens and their families.

14.6 Promoting Healthy Eating and Physical Activity Behaviors

Meeting the challenge of improving the nutritional health of teenagers requires the integrated efforts of teenagers, parents, educators, health-care providers, schools, communities, the food industry, and policymakers all working together to create more opportunities for healthful eating.

Health professionals need to rethink how they frame messages to adolescents. Decades ago, Leverton pointed out that, too often, teenagers have been given the message that good nutrition means "eating what you don't like because it's good for you." Rather, they should be told to "eat well, because it will help you in what you want to do and become."[53] This still applies to adolescents today. Teens are present-oriented and tend to be less concerned about how their eating will affect them in later years. However, they are concerned about immediate, socially relevant issues such as their physical appearance, achieving and maintaining a healthy weight, performing well academically, and having lots of energy. Others are concerned with environmental, religious, cultural or moral aspects of food. Even though adolescents need to be aware of the long-term risks of an unhealthy diet and benefits of a more healthful one, focusing on short-term, tangible benefits will have more appeal to them and is more likely to result in behavior change.

The Home Environment and Parental Involvement

Parents should be targets for nutrition education because they fill the role of gatekeepers of foods in the home and serve as role models for eating behaviors. Even though parents may have little control over what their teenagers

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are eating outside the home, they have more control in the home environment. Teens tend to eat what is available and convenient. Parents can capitalize on this by stocking the kitchen with a variety of nutritious ready-to-eat foods and limiting the availability of high-sugar, high-fat foods within the home. Research has shown that availability of healthy foods including fruits and vegetables in the home is associated with higher intake of these foods and lower BMI, while availability of unhealthy foods in the home is associated with higher intakes of snack foods and fast foods and lower intakes of fruits and vegetables.[54,55]

Parents of teenagers may have concerns over whether or not they should prepare alternative foods for teens when they don't like what is served, while others may restrict intake of specific foods to promote health or prevent obesity. In general, adolescents should be involved in food purchasing and preparation as often as possible to provide them with food-preparation and decision-making skills. A review of literature found that involvement in food purchasing and home preparation is linked to a wide variety of positive outcomes including stronger personal relationships and cultural identity, and better health and nutrition status, including dietary markers.[55] Parents should refrain from offering specially prepared foods for adolescents who do not like what is served, and should instead be encouraged to provide a balanced meal. Research has found that serving adolescents fruits, vegetables, and dairy at dinner time is related to higher intakes of these foods both during adolescence and 5 years later, during young adulthood.[55,56] Recent data suggest that adolescents who are exposed to healthier food environments, including more frequent family meals and the availability of healthy foods in the home, as more likely to report these behaviors as adults and as parents to their own children.[56]

School-Based Education, School Meals, and Wellness Activities

School-based programming can play an important role in promoting lifelong healthy eating and physical activity. Efforts to promote physical activity and healthful eating should be part of a comprehensive and coordinated school health program, that includes school health instruction (curriculum), physical education classes, school food and nutrition services, school-based health services (screening and preventive counseling), health promotion programs for faculty and staff, family engagement, and community involvement. The Centers for Disease Control and Prevention (CDC) created the Whole School, Whole Community, Whole Child (WSCC) model for comprehensive school nutrition and physical activity programs to be used by school administrators, educators, health professionals, and policy makers (Table 14.12).[57] The WSCC (https://www.cdc.gov/healthyschools/wscc/strategies.htm) focuses on 10 components of child health, many of which nutrition play key roles in overall adolescent health and well-being (Figure 14.5). For instance, the CDC specifically recommends nutrition and healthy eating as components of a comprehensive school health education curriculum. The WSCC advises that all schools meet Smart Snacks in Schools Nutrition Standards (discussed later in this section) and stresses the need to market only healthy foods and beverages and the importance of assuring that school staff role model healthy eating behaviors. The recommendations included for employee wellness focus on healthy eating as a risk reduction strategy for chronic diseases. There are many additional ways in which nutrition can be incorporated into the WSCC model to assure that schools provide healthy eating and nutrition education

Table 14.12 School health guidelines to promote healthy eating and physical activity

Guideline 1.	Use a coordinated approach to develop, implement, and evaluate health eating and physical activity policies and practices.
Guideline 2.	Establish school environments that support healthy eating and physical activity.
Guideline 3.	Provide a quality school meal program and ensure that students have only appealing, healthy food and beverage choices offered outside of the school meal program.
Guideline 4.	Implement a comprehensive physical activity program with quality physical education as the cornerstone.
Guideline 5.	Implement health education that provides students with the knowledge, skills, and experiences needed for healthy eating and physical activity.
Guideline 6.	Provide students with health, mental health, and social services to address healthy eating, physical activity, and related chronic disease prevention.
Guideline 7.	Partner with families and community members in the development and implementation of healthy eating and physical activity policies, practices, and programs.
Guideline 8.	Provide a school employee wellness program that includes healthy eating and physical activity services for all school staff members.
Guideline 9.	Employ qualified persons, and provide professional development opportunities for physical education, health education, nutrition services, and health, mental health, and social services staff members, as well as staff member who supervise recess, cafeteria time, and out-of-school-time programs.

Source: Centers for Disease Control and Prevention, School Health Guidelines to Promote Healthy Eating and Physical Activity. *Morb Mortal Wkly Rep.* (September 16, 2011)/60(RR05), 1–71.

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Figure 14.5 Whole School, Whole Community, Whole Child Model.

Source: Centers for Disease Control and Prevention, Adolescent and School Health. Available at http://www.cdc.gov/healthyyouth/images/schoolhealth/wsccmodel.png.

options for youths, school staff, and families. An accompanying series of classroom resources called BAM! (Body and Mind) includes units on nutrition and physical activity (https://www.cdc.gov/healthyschools/bam/nutrition.htm). Another curriculum that supports the WSCC model is CATCH (Coordinated Approach to Child Health), which has been extensively evaluated over the past several decades. These programs follow the CDC School Health Guidelines (https://www.cdc.gov/healthyschools/npao/strategies.htm) that include recommendations to promote healthy eating and lifelong physical activity, including school policies and physical and social environments that encourage and enable physical activity and healthy eating, developmentally appropriate nutrition and physical education curricula and instruction, personnel training, family and community involvement, and program evaluation. The CDC has also published the School Health Index for Middle School/High School, which can be used when planning and evaluating school health and nutrition programs.[58] This tool will help schools identify strengths and weakness of their specific policies and programs, can help them determine areas for improvement; provides examples for action items that can be incorporated into future plans; and gives guidance on how to engage parents, teachers, students, and the broader community in developing comprehensive school health and nutrition services.

Schools offer an ideal setting for promoting physical activity through physical education classes. Eighty percent of U.S. high schools require physical education be taught as a required part of the health curriculum (with a mean of 5.8 hours of content provided), and 96 percent require students take physical education.[58–60] Yet 52 percent of high school students reported not attended a physical education class during the school week and half do not participate in organized sports teams in school or within their community.[59] Lack of interest or perceived ability related to competitive team sports may be a barrier for many teens.[35] Community programs that offer noncompetitive activities where all teens get an opportunity to actively participate for at least 30 minutes or more are essential to meeting physical activity goals for youths, because most physical activity among adolescents, particularly among female teens, occurs outside of schools. Activities that allow students to participate fully for most or all of the time include walking or jogging, stationary or nonstationary bicycling, hiking, noncompetitive swimming, yoga, zumba and other dance classes, pilates, noncompetitive cross-country skiing, ice skating, golf, and tennis. These are also activities that can be done throughout the life span, on an individual or group basis.

Nationally, nutrition and dietary behavior is required as part of health education curricula in 85 percent of school districts, with a mean of 7 hours of instruction provided.[59,60] By the time they enter high school, students are in the process of cognitive and social development changes that permit more advanced nutrition education concepts and activities. The ability for more abstract thinking, coupled with the changing psychosocial terrain of young adolescents, provides both a challenge and a unique opportunity for educators to offer new learning and teaching strategies to encourage them to make healthful food choices. Early adolescence is an ideal time to teach students how to assess their own behavior and set goals for change. As adolescents begin the social process of individuation, they become ready and eager to make their own decisions and show their individuality. Nutrition education often fails to take advantage of the social and cognitive transitions of adolescence to promote the adoption of more healthful behaviors.

Because knowledge alone is inadequate when students must decide which foods to eat and how to deal with peer and social influences, as well as with a widely available supply of foods that are high in solid fats and added sugars, the focus of nutrition education and teaching methods should be on behavior-change strategies and skill acquisitions to make healthful food decisions. Teaching methods found to be most effective in school health education curricula include the following:

- Use of discovery learning
- Use of student learning stations, small work groups, and cooperative learning techniques
- Cross-age and peer teaching/mentoring
- Positive approaches that emphasize the intrinsic value of good health

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- Use of personal commitment to change
- Goal setting
- Provision of opportunities to increase self-efficacy in modifying health behaviors

A focus on eating behaviors, as opposed to body weight, is a more weight-inclusive approach to nutrition education which is more engaging to adolescents of all body sizes and weights, and has been shown to result in positive health outcomes such as improved blood pressure and self-esteem while reducing depressive symptoms.[61] Most important, adolescents need to be given repeated opportunities to develop, demonstrate, practice, and master the skills needed to make informed decisions and cope with social influences (Photo 14.1). To be effective, nutrition education programs also must take into account cultural factors as well as the developmental processes of adolescents.

As previously mentioned, teens eat a significant amount of food at school, whether through a la carte choices, vending, school stores, or school meal program offerings. Thus, assuring healthy school food options at schools can have a big impact on the health and nutritional status of adolescents. The National School Lunch Program (NSLP) and School Breakfast Program (SBP) are federally sponsored nutrition programs administered by the U.S. Department of Agriculture (USDA) in conjunction with state and local education agencies. There are food-based requirements for the SBP and NSLP that help to ensure reimbursable meals meet national dietary guidelines such as the DGAs, particularly focusing on modifying dietary behaviors of concern in the diets of youths such as assuring adequate fruit, vegetable, low fat dairy and whole grain intakes, while moderating levels of sodium, solid fats, and added sugars. In accordance with the 2012 final rule for nutrition standards, reimbursable meals must provide a minimum amount of specific types of vegetables served each week (Table 14.13).[62] A new revision to the rule in the 2022–2023 school year will allow schools to provide flavored low-fat milk in addition to unflavored milk; will require a gradual decrease in sodium for school lunches over several years; and will require that 80 percent or more of grains served meet the definition of whole grain–rich foods (50 percent whole-grain content or more).[63] The Healthy, Hunger Free Kids Act Final Rule (HHFKA) updated the nutrition standards required for school meals, calling for "Smart Snacks in Schools," which requires that all foods and beverages sold to students during regular school hours meet these standards.[62]



Peggy Greb/USDA

Photo 14.1 School meals are a significant source of energy and nutrients for adolescents.

Participation in the NSLP and SBP was affected by periodic school closures and sustained virtual instruction that occurred during the COVID-19 pandemic. It is estimated that participation in the SPB fell by 5 percent, while participation in the NSLP fell by 31 percent.[64] The USDA issued a variety of temporary waivers for meal programs that allowed flexibility in approaches to provide meals to students. Among the most impactful changes were waivers that reduced the administrative burden of determining program eligibility by providing free meals to all students.[64] These changes also resulted in reduced meal shaming (the practice of withholding meals from students with outstanding meal program debt) and reducing stigma of meal program participation. The long-term fate of these waivers, many of which have been extended, is still unknown.

All school districts with a federally funded school meals program are required to develop and implement wellness policies that address nutrition and physical activity.[65] At a minimum, each local policy must include:

- Goals for nutrition promotion and education, physical activity, and other school-based activities that are designed to foster student wellness
- Nutrition standards and guidelines that are consistent with federal regulations for all foods sold on each school campus during the school day, with the objectives of promoting student health and reducing childhood obesity
- Guidelines for foods and beverages provided but not sold to students during the school day, such as classroom snacks or parties, foods and beverages used for rewards or incentives, etc.

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Table 14.13 Nutrition standards and meal patterns in the National School Lunch and School Breakfast Programs, Final Rule, 2012 with updates from the 2022 Transitional Guidelines for Sodium, Whole Grains, and Fluid Milk Final Rule

	Breakfast		Lunch	
	Grades 6–8	Grades 9–12	Grades 6–8	Grades 9–12
Meal Pattern	**Amount per Week (Minimum per Day)**			
Fruits (cups)	5 (1)	5 (1)	2½ (½)	5 (1)
Vegetables (cups)	0	0	3¾ (¾)	5 (1)
Dark Green	0	0	½	½
Red/Orange	0	0	¾	1¼
Beans/Peas/Legumes	0	0	½	½
Starchy	0	0	½	½
Other	0	0	½	¾
Additional vegetables to reach total	0	0	1	1½
Grains (oz/equivalent) with 80% whole grain–rich choices	8–10 (1)	9–10 (1)	8–10 (1)	10–12 (2)
Meats/Alternatives (oz/equivalent)	0	0	9–10 (1)	10–12 (2)
Fluid milk (cups) of flavored or unflavored low-fat (1%) milk or soy-based milk substitute	5 (1)	5 (1)	5 (1)	5 (1)
OTHER REQUIREMENTS: DAILY AMOUNT BASED ON THE AVERAGE FOR A 5-DAY WEEK				
Minimum-maximum kcal	400–500	450–600	600–700	750–850
Saturated fat (% total energy)	< 10	< 10	< 10	< 10
Sodium (mg)	≤ 600	≤ 640	≤ 1,360 (2022) 1,225 (2023)	≤ 1,420 (2022) 1,280 (2023)
Trans fat (g/serving)	0	0	0	0

Sources: 1. *Federal Register*. Volume 77, No. 17, Part II. 7 CFR Parts 210 and 220. Nutrition Standards in the National School Lunch and School Breakfast Programs; Final Rule. January 26, 2012. 2. Child Nutrition Programs: Transitional Standards for Milk, Whole Grains, and Sodium, 87 *Fed. Reg.* 6984 (Feb. 7, 2022). 3. USDA Helps Schools Build Back Better, Issues Transitional Nutrition Standards for Coming School Years, USDA Food and Nutrition Service (Feb. 4, 2022). Available at https://www.fns.usda.gov/news-item/usda-0037.22.

- Policies that restrict marketing of foods and beverages to only those meeting Smart Snacks in Schools standards
- Documentation of community involvement—including parents, students, and representatives of the school food authority, the school board, school administrators, and the public—in the development, implementation, and evaluation of the school wellness policy
- Public updates provided on the content and implementation strategies of local policies
- Physical education teachers and school health professionals allowed to become involved with the development of school wellness policies and related activities
- All stakeholders, including students, parents, and administrators, are allowed to participate in the implementation of school wellness policies as well as periodic review and updates of policies
- The most current local assessment of how well the policy was implemented

School wellness committees are required to meet periodically (at least once every 3 years) to measure progress of the wellness policy, including:

- Extent of compliance with USDA regulations
- How well the local policy compares to model school wellness policies
- Achievement of goals of local policies

State agencies, usually the department of education or public instruction who administer the child nutrition programs, should assess compliance with wellness policies every 3 years to document:

- Methods for public dissemination of the policy and assessment outcomes
- A copy of the wellness policy
- A description of which stakeholders participate in wellness policy review and updates

Resources are available to local districts and state agencies from the USDA and the CDC to assist with the development, implementation, and evaluation of school wellness policies.[64]

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A promising practice to assist youths in making healthy choices in the lunchroom, which can be implemented as part of a comprehensive school wellness policy, is that of behavioral economics. Sometimes referred to as *nudging* or *food choice architecture,* behavioral economics strategies utilize the principle that most people make food choices quickly and irrationally, based on perceptions rather than knowledge; in other words, food choices are based on emotional or instinctual reactions rather than through evidence-based or rational decisions. Making "the healthy choice the easy choice" by creating default choices that are healthy is a low-cost way to drive a behavior change among youths.

Behavioral economics strategies to improve eating behaviors often focus on the four "Ps" of marketing: price, placement, promotion, and product. Such strategies focus on "making the healthy choice the easy choice." Schools have reported success in utilizing a variety of behavioral economics strategies, including the following:[66]

- Place healthy foods at the beginning of food lines and in front of less healthy foods and/or in multiple places within the lunch line
- Promote fruits, vegetables, and salads by displaying them in attractive ways
- Creating posters, signage, stickers, or labels that promote healthy food items and/or giving foods creative names
- Having food service staff use verbal prompts to encourage healthy foods throughout the lunch line and at the register
- Conducting taste tests and using student-led recipe competitions or other student-led activities to encourage students to try healthy food options
- Place less healthy foods just out of reach to make it inconvenient to access them or placing more healthful choices (unflavored milk) on top of or in front of less healthful choices (flavored milk)
- Price healthier food products more competitively and less healthy food items at a higher level
- Provide healthier food products through a "preorder" or "quick service line" to encourage their selection
- Promote fruits and salads by placing them just before the cash register where students will be waiting and where last-minute "grabs" are made

Asking students in the lunch line if they'd rather have the baby carrots or roasted beets provides the student the ability to make a healthy choice, while also assuring that the school meal pattern requirement of a red or orange vegetable is met. Prompting students to make a choice with phrases such as, "Looks like you forgot to take a vegetable. How about trying . . .?" or, "That meal comes with another side. You can grab a piece of fruit or a salad just before you get to the cash register." Such strategies and prompts can be made at home and in food venues outside of schools as well, to encourage healthy food choices in all settings. An evaluation of school staff-led implementation of behavioral economics strategies found that these interventions resulted in students selecting and/or consuming more fruits and vegetables.[66] Behavioral economics strategies such as nudging have been found to also decrease plate waste and to increase meal participation rates.[67]

Community Engagement to Create Nutritionally Supportive Environments

Promoting lifelong healthy eating and physical activity behaviors among adolescents requires attention to the multiple behavioral and environmental influences in a community. Adolescents are most likely to adopt healthy behaviors when they receive consistent messages through multiple channels (e.g., community, home, school, and the media) and from multiple sources (e.g., parents, peers, teachers, health professionals, and the media). Because most physical activity occurs outside the school setting, community parks and recreation programs are essential for promoting physical activity among young people. Healthy eating can be integrated into these efforts by providing nutritious snacks, food-preparation activities, and other skill-based learning activities. Community coalitions or task forces can be established to assess community needs and to develop, implement, and evaluate physical activity and nutrition programs for young people. The use of different creative settings and outlets to deliver innovative nutrition education programs to parents to encourage recommended behaviors—including such settings as work sites, places of worship, community centers, libraries, supermarkets, hair and nail salons, shopping centers, housing complexes, and restaurants—should be explored.

Learning about nutrition can involve more than just understanding the health effects of foods, beverages, and nutrients. It can also be combined with the acquisition of other skills that are important for adolescents, such as leadership development and mentoring, entrepreneurship, self-advocacy, and positive self-concept. Incorporating hands-on activities such as gardening, recipe development, business plan development, and marketing can effectively engage students while also teaching them the importance of nutrition to overall health and well-being. Examples of comprehensive programs are Urban Roots and Roots for the Home Team.

Urban Roots, located in St. Paul, Minnesota (http://urbanrootsmn.org), was developed to build vibrant, healthy communities through food, conservation, and youth development (Photo 14.2). The program offers three main youth development programs that strive to improve eating behaviors and engage and educate youth:

- *The Market Garden Program.* This program offers paid internships to youth who plant, maintain, and harvest urban garden plots. The produce is offered

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Photo 14.2 Reinforcing healthy eating habits through active learning and cooking.

for sale to the community through a community supported agriculture (CSA) program and a farmer's market stand, is sold to local restaurants, is used in the cooking program, and is donated to local food shelves, in addition to providing produce for the families of the youth involved. Youths learn entrepreneurial and business skills in addition to gardening and growing skills.

- *The Conservation Program*. This program offers paid internships to youths who install and maintain rain gardens, renovate local parks and nature sanctuaries, create attractive streetscapes, and work to remove invasive species from native planting areas. Interns and staff also provide classes and activities for elementary- and middle-school aged youths.
- *The Cook Fresh Program*. Paid interns and staff teach youth methods for preparing fresh garden produce. Participants also create "seed-to-table" lunches alongside chefs during summer programming as well as healthy, low-cost recipes, and assist in teaching peer- and family-focused cooking classes. Entrepreneurial skills are also taught as part of the Cook Fresh program, through teaching scalable cooking skills and developing value-added products from Urban Roots garden produce; these products, which may include chutneys, salsas, and sauces, are sold to provide funding for programming.

Urban Roots provides 60 internships to a highly diverse group of teens, many from low-income households. More than 300 community members participate in Cook Fresh program activities annually.[68] Evaluation results suggest that 88 percent of youths report increasing their communication, critical thinking, and problem solving skills through the internship experience, with 85 percent able to identify career opportunities, 84 percent saying they increased their sense of initiative, and 83 percent reported increased knowledge.[68]

Roots for the Home Team (www.rootsforthehometeam.org) is another model program that started in St. Paul, Minnesota. The program works with minority youths, often from low-income households, and integrates nutrition, gardening, and cooking with leadership development, entrepreneurial skills, and career planning. Thirty youths who are working with community gardens participate in the 3-year-long *Finding Your Roots* program curriculum each year, which provides them with personal and professional development activities. The youths work with celebrity chefs to develop new salad recipes that will be sold at professional sports venues through the youth-led *Salad-Up!* salad cart and at other venues in the community. Nearly 14,000 salads were served in 2021.[69] Nearly all youth participants (97 percent) felt they had developed skills to influence their future and their community, while 73 percent say they had an expanded future career definition. Programs such as Urban Roots and Roots for the Home Team show how adolescents can be engaged in activities that promote healthy, sustainable eating habits as well as empower teens to become agents for change in their communities.

Key Points

1. Rapid rates of physical growth and development experienced by adolescents significantly increase their needs for energy, protein, vitamins, and minerals.
2. Body composition changes dramatically during puberty, with the percentage of body fat increasing among female adolescents but decreasing among male adolescents.
3. Adolescents will not fully develop abstract reasoning and critical thinking skills until late in adolescence or early adulthood; therefore, nutrition education messages should be simple and concrete, and should relate to activities common in their current everyday lives.
4. Snacking among adolescents is extremely common, and provides a significant proportion of daily energy and nutrient intakes.
5. Meal skipping is common during adolescence, with breakfast the most commonly skipped meal.

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6. Well-planned vegetarian diets can provide adequate nutrients for teens. Vegan dietary patterns are more likely to lack critical nutrients; thus, adolescents who frequently or only consume vegan meals may require greater dietary guidance and more nutrition monitoring.
7. Only 17 percent of teens meet both aerobic physical activity and muscle- and bone-strengthening guidelines.
8. Forty percent of adolescent's report eating less than one serving of fruit and less than one serving of vegetable each day.
9. School environments play a major role in shaping the dietary habits of teens. Strong school food standards and comprehensive school health guidelines help assure that school eating and physical activity environments mirror national recommendations. The use of behavioral economics principles can help assure students frequently make healthy choices.

Review Questions

1. Which of the following is considered a risk factor for low vitamin D status?
   a. Dark skin pigmentation
   b. Light skin pigmentation
   c. Low calcium intake
   d. High calcium intake
2. Sexual maturation rating is a method of determining when adolescents have completed menarche or spermarche.

   _____ True _____ False
3. Which of the following factors contributes to increased iron needs among adolescents?
   a. Increased growth velocity during puberty
   b. Low dietary intake of iron
   c. Onset of menarche
   d. All of the above
4. School wellness policies are only required for schools that offer à la carte foods for sale.

   _____ True _____ False
5. The nutrients most likely to be missing from the diets of adolescents are:
   a. Vitamins A, D, iron, zinc, and protein
   b. Vitamins B_6, D, B_{12}, iron, and calcium
   c. Vitamins B_6, B_{12}, folate, zinc, and calcium
   d. Vitamins B_6, B_{12}, folate, iron, and protein
6. Which of the following is NOT a behavioral economics strategy to improve food choices?
   a. Competitive pricing of healthy foods
   b. Hanging MyPlate posters in the cafeteria
   c. Placing fruit in attractive bowls
   d. Creating quick food lines that offer salads and vegetarian entrees
7. What is biological age (SMR) and why should it be used instead of chronological age to determine adolescent nutrient needs?
8. Which of the following methods are effective education strategies for health education with adolescents?
   a. Use of discovery learning
   b. Use of student learning stations, small work groups, and cooperative learning techniques
   c. Cross-age and peer teaching/mentoring
   d. All of the above
9. Which of the following pieces of legislation determines specific components and requirements of school wellness policy guidelines?
   a. Child Nutrition and WIC Reauthorization Act
   b. School Health Programs and Policies
   c. Whole School Whole Community Whole Child
   d. Healthy, Hunger-Free Kids Act

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Adolescent Nutrition

Conditions and Interventions

Prepared by Jamie Stang

Learning Objectives

After studying the materials in this chapter, you should be able to:

15.1 Describe at least five chronic health issues that are considered comorbid conditions of adolescent obesity, including the proposed mechanisms by which obesity raises the risk for these conditions.

15.2 Understand the prevalence and patterns of supplement use among adolescents, including nutritive, nonnutritive, and performance enhancing supplement use.

15.3 Determine the unique energy, protein, and micronutrient needs of competitive adolescent athletes who have not yet completed growth and development.

15.4 Compare and contrast national dietary recommendations to prevent and treat hypertension and hyperlipidemia in adolescents.

15.5 Differentiate between disordered eating behaviors and eating disorders based on frequency and severity of symptoms and anticipated outcomes.

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Introduction

Multiple factors influence the nutritional needs and behaviors of adolescents. This chapter presents specific nutrition concerns that affect significant numbers of adolescents, including overweight, participation in competitive sports, substance abuse, eating disorders, hypertension, and hyperlipidemia. Because being overweight, sports participation, and eating disorders affect a larger group of adolescents than other conditions, they are presented in greater detail.

15.1 Overweight and Obesity

Overweight and obesity are prevalent health concerns among adolescents, which may impact risk of other chronic health conditions. Weight status among adolescents is most commonly assessed by calculating body mass index (BMI). BMI is calculated by dividing a person's weight (kg) by their height^2 (m^2) (Table 15.1). The Centers for Disease Control and Prevention (CDC) has an online BMI calculator (available at http://nccd.cdc.gov/dnpabmi/Calculator.aspx) that can be used to quickly and accurately calculate BMI values for youth. BMI values are compared to age- and gender-appropriate percentiles to determine the appropriateness of the individual's weight for height. Based on these growth curves, youth with BMI values greater than the 85th but lower than the 95th percentile are considered overweight; those with BMI values above the 95th percentile are considered obese.[1] Extreme obesity is diagnosed when adolescents are at ≥120% of the 95th percentile or have a BMI of ≥35.[2] Growth curves based on BMI values for children and adolescents are available from the National Center for Health Statistics. An example of a BMI growth curve is shown in Figure 15.1. It should be noted that the use of BMI metrics for defining effectiveness of outcomes of weight management programs and services has been called into question, particularly for severe obesity.[3] Alternative criteria are being investigated however the use of BMI for screening continues to be used in national surveillance systems and is recommended by professional health-care guidelines.[3]

Data from the National Health and Nutrition Examination Survey (NHANES) suggest that 16 percent of U.S. youths aged 2–19 are overweight, 19 percent are obese, and 6 percent are severely obese.[4] Trends in weight status are concerning, with more dramatic shifts over time among higher weight classifications. For example, while overweight among U.S. youths 2–19 years of age increased by about 60 percent between 1971 to 2018, obesity almost quadrupled and severe obesity went up sixfold.[4] There are gender differences in these trends. Overweight increased by about 15 percent among male adolescents and by about 18 percent among female adolescents during that time frame. Obesity quadrupled among male teens but increased 3.5-fold among female teens from 1971–2018 while severe obesity

Table 15.1 How BMI is calculated and interpreted for children and teens

Calculating and interpreting BMI using the BMI Percentile Calculator involves the following steps:

1. Before calculating BMI, obtain accurate height and weight measurements. Refer to Measuring Children's Height and Weight Accurately At Home. (www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html).
2. Calculate the BMI and percentile using the Child and Teen BMI Calculator (http://nccd.cdc.gov/dnpabmi/Calculator.aspx). The BMI number is calculated using standard formulas (www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html).
3. Review the calculated BMI-for-age percentile and results. The BMI-for-age percentile is used to interpret the BMI number because BMI is both age- and sex-specific for children and teens. These criteria are different from those used to interpret BMI for adults—which do not take into account age or sex. Age and sex are considered for children and teens for two reasons:
   - The amount of body fat changes with age. (BMI for children and teens is often referred to as BMI-for-age.)
   - The amount of body fat differs between girls and boys.

   The CDC BMI-for-age growth charts for girls and boys (www.cdc.gov/growthcharts) take into account these differences and allow translation of a BMI number into a percentile for a child's or teen's sex and age.
4. Find the weight status category for the calculated BMI-for-age percentile as shown in the following chart. These categories are based on expert committee recommendations.

Weight Status Category	Percentile Range
Underweight	Less than the 5th percentile
Healthy weight	5th percentile to less than the 85th percentile
Overweight	85th to less than the 95th percentile
Obese	Equal to or greater than the 95th percentile

The CDC BMI-for-age growth charts are available at: CDC Growth Charts: United States. www.cdc.gov/growthcharts/clinical_charts.htm.

Source: Centers for Disease Control and Prevention.

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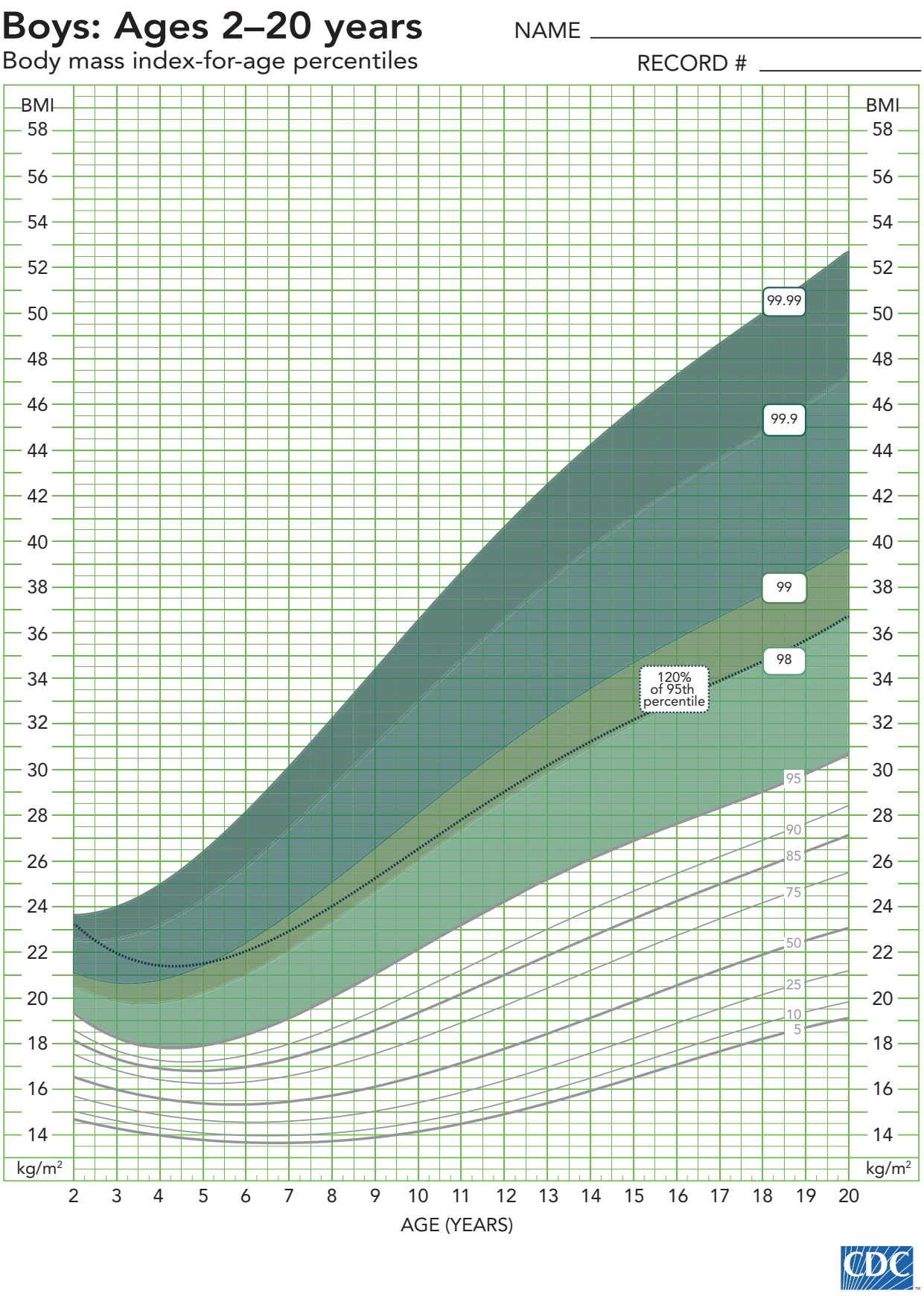


Figure 15.1 CDC Growth Charts: The United States.

Source: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion, 2000. Available at https://www.cdc.gov/growthcharts/extended-bmi.htm.

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increased about sevenfold among male adolescents and fivefold among female adolescents. Thus, the trend toward the highest weight categories has occurred to a greater extent among male teens than among female teens, though rates of all weight classifications are high among both genders.[4]

When examining only youths experiencing obesity who are 12–19 years of age, the prevalence among male teens increased from 4.5 percent (1966–1970) to 22.5 percent (2017–2018), while the prevalence among female teens increased from 4.7 percent to 19.9 percent over the same time frame.[4] When trends are examined by race/ethnicity between the years of 1988 and 2018 among male adolescents, data suggest that increases were highest among Mexican American male adolescents (14.8 percent increasing to 29 percent), followed by non-Hispanic Black male adolescents (10.6 percent to 19.4 percent), and non-Hispanic White male adolescents (9.7 percent to 17.4 percent). Among female youths during the same time frame, increases in obesity were greatest among non-Hispanic Black female adolescents (14.5 percent increasing to 29.1 percent) followed by non-Hispanic White and Mexican American female adolescents (8.6 percent increasing to 14.8 percent, and 13.8 percent increasing to 24.9 percent, respectively).[4]

Exact reasons for increases in both prevalence and severity of obesity or the race/ethnicity and gender differences have not been definitively identified. Environmental factors, or interactions between genetic and environmental factors, are the most likely causes of the dramatic rise in overweight and obesity. Risk factors for the development of overweight and obesity among children and adolescents include having at least one overweight or obese parent; low socioeconomic status; being of African American, Hispanic, or Native Indian/Alaska Native race/ethnicity; and being diagnosed with a chronic or disabling condition that limits mobility.[1,5] Inadequate levels of physical activity and consuming diets high in total calories and added sugars and fats are behavioral risk factors common among a significant proportion of adolescents (Chapter 14).[1,5] These environmental factors increase the risk of developing obesity if an adolescent is genetically predisposed to obesity. Additional potential risk factors may include daily amount of screen time, duration of sleep, infant feeding practices such as breastfeeding versus infant formula feeding and age of introduction of solid foods, and weight and health status of mother during pregnancy.[5] Research suggests that youths who become obese before or around the occurrence of adiposity rebound (the rise in BMI that occurs between 1 and 5 years of age) are more likely to remain overweight into adulthood than children who remain within normal BMI limits during that period of life.[2,6]

Health Implications of Adolescent Overweight and Obesity

A range of medical and psychosocial complications accompanies overweight among adolescents, including hypertension, dyslipidemia, insulin resistance, type 2 diabetes mellitus, sleep apnea and other hypoventilation disorders, orthopedic problems, hepatic diseases, body image disturbances, and lowered self-esteem.[1,2,5–7] Longitudinal studies of obesity and chronic disease risk among youth suggest an increased risk of morbidity and premature mortality from coronary heart disease, stroke, diabetes, asthma, and hypertension among adults who were overweight or obese during adolescence.[1,2,5–7]

Assessment and Treatment of Adolescent Overweight and Obesity

All adolescents should be screened for appropriateness of weight-for-height on a yearly basis, or more frequently if concerns about excessive weight gain are present. Teens with multiple risk factors for obesity require an in-depth medical assessment to diagnose potential comorbid complications.[1,2,8] Figure 15.2 provides recommended screening and referral procedures for adolescents with a BMI ≥85th percentile for age and gender.

National guidelines for the treatment of child and adolescent overweight and obesity have recently changed.[8] Obesity is considered a chronic condition, therefore a chronic care model of intervention is recommended. Specific treatment should be based on each individual's factors such as medical history, family structure, developmental stage and social and environmental factors. Motivational Interviewing (MI) is the preferred

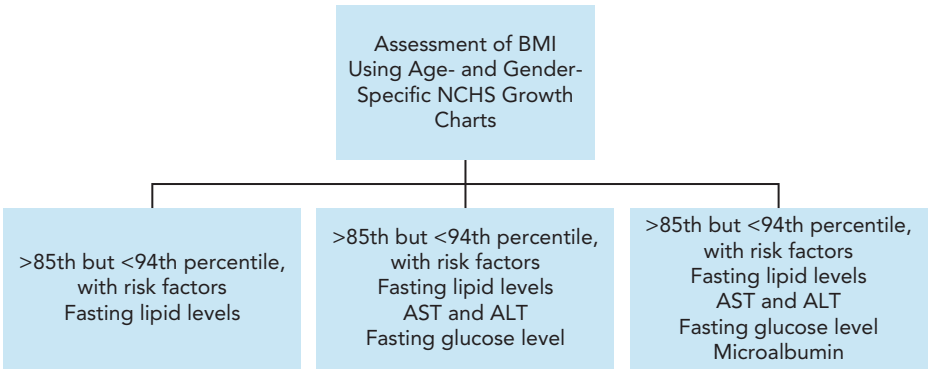


Figure 15.2 Primary care assessments based on adolescent BMI.

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counselling technique to be used, as it identifies an individual or family's interests and perceived ability to make changes.[8] MI allows Registered Dietitians/Nutritionists and other health-care providers to engage with families, focusing on their unique situation and the specific set of social determinants of health and nutrition they may encounter. During MI, the adolescent and their family should work with a multidisciplinary team of providers to identify behavior change strategies and to work through any challenges that they encounter.

Intensive health behavior and lifestyle treatment (IHBLT) guidelines have been identified for adolescent obesity interventions which are to be delivered in a team approach to care.[8] The recommended membership of the multidisciplinary team includes a physician, physician assistant, or pediatric nurse practitioner; a behavioral health specialist, social worker, or mental health counselor; a registered dietitian/nutrition (RDN); an exercise physiologist or physical therapist; and a nurse. The adolescent and their family members should be considered integral parts of the team. The American Academy of Pediatrics (AAP) IHBLT model suggests that treatment can occur in a health-care setting or a community health setting.[8] Treatment should be continued for 3 to 12 months, with 26 or more contact hours in that timeframe. It can be through individual family/adolescent counselling, group intervention or both. While face-to-face counselling is preferred, the AAP does recognize the importance and effectiveness for virtual interventions for youth who are not able to access services in person.

Pharmacotherapy is not recommended as the sole treatment option for adolescent obesity, but has been approved as an adjunct to IHBLT, especially when significant co-morbidities are present.[8] Only Food and Drug Administration (FDA)–approved medications should be used and they should always be accompanied by a high-intensity lifestyle modification program and close clinical monitoring.[2,8] The Endocrine Society has compiled a good review of FDA-approved and off-label use medications that are used in the treatment of adolescent obesity.[2]

Metabolic and bariatric surgery has been used to treat severely obese adolescents who exhibit significant comorbidities that have not resolved with intensive lifestyle intervention or pharmacotherapy.[8,9] Guidelines for the use of metabolic and bariatric surgery among adolescents have been published.[9] To be considered as a candidate for bariatric surgery, adolescents should have a BMI of >35 (or 120 percent of the appropriate 95th percentile) with a significant comorbidity or a BMI of >40 (or 140 percent of the appropriate 95th percentile) with or without comorbidities. There is controversy regarding whether or not bariatric surgery in youth who have not completed puberty may cause reduction in linear growth; however, recent guidelines have suggested there is no reason to limit access to metabolic and bariatric surgery based on bone age or Tanner stage.[9]

The two most commonly recommended procedures for adolescents in the United States are the vertical sleeve gastrectomy and the Roux-en-Y gastric bypass procedures; the adjustable gastric band is not currently approved in the United States for use in adolescents outside of clinical trials. Both vertical sleeve gastrectomy and Roux-en Y gastric bypass are considered safe and effective. The likelihood of complications associated with each method are related to the ability to adhere to nutrient supplement and medication protocols, smoking or second-hand smoke exposure, and the presence and severity of gastro-esophageal reflux disease.[9]

Nutrition and diet recommendations for postoperative adolescents will vary by the type of surgery performed. In general, the diet will advance from a high-protein full liquid diet for the first 5 days to increased volumes and textures of foods, finally reaching solid foods by 2 to 3 weeks' post-surgery.[10] It may take 4 to 6 months or longer to advance to a typical solid food diet.

Three to four small meals per day that are high in protein and moderate in fat and carbohydrate levels are recommended to reduce dumping syndrome. Fluid intake should be encouraged to at least 2 to 3 liters per day of non-sugar-sweetened beverages, and postsurgical patients often find it best to not drink fluids within 30 minutes before or after meals to avoid gastrointestinal upset or dumping symptoms. Nausea may be common and can be controlled with medications.[10]

Long-term dietary recommendations for postsurgical patients include:[10]

- Eight to 12 servings (8 oz each) of sugar-free beverages each day
- Thirty to 60 minutes of daily physical activity as directed by postoperative care team
- Consuming a diet with plenty of protein
- Three to four small meals per day, with protein consumed first at each meal
- Daily supplementation with a multivitamin mineral supplement and additional supplementation to achieve intakes listed in Table 15.2

Nutritional monitoring is important in both the short- and long-term follow-up care of adolescents who have undergone bariatric surgery. Biochemical nutritional assessment should include serum iron, ferritin, and folate, thiamin, vitamin B_{12}, methylmalonic acid, homocysteine, 25-hydroxy vitamin D, and calcium; parathyroid hormone; alkaline phosphatase; hemoglobin A1c; albumin and total protein; and magnesium, phosphorus, vitamin A, zinc, copper, and selenium at 2 months' post-surgery, 6 months' post-surgery, and annually.[10] Assessment of hunger should be addressed with teens after surgery, and they should be instructed to stop eating and drinking at the first sign of fullness to avoid overconsumption and reduce the risk of dumping syndrome.

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Table 15.2 Recommendations for nutrition after bariatric surgery in adolescents

	Recommendations for Daily Intake	
	Females	**Males**
Protein	1.0–1.5 g/kg ideal body weight (around 46 g)	1.0–1.5 g/kg ideal body weight (around 52 g)
Carbohydrate	Avoid added sugars, limit refined carbohydrates	Avoid added sugars, limit refined carbohydrates
Fat	Avoid high fat foods, encourage foods with essential and omega-3 fatty acids, supplement with omega-3 fatty acids as needed	Avoid high fat foods, encourage foods with essential and omega-3 fatty acids supplement with omega-3 fatty acids as needed
Fluids	2.3 liters, avoid drinking within 30 mins of a meal	3.3 liters, avoid drinking within 30 mins of a meal
Thiamin	1 mg	1.2 mg
Vitamin B_6	1.2 mg	1.3 mg
Folic acid	400 µg	400 µg
Vitamin B_{12}	2.4 µg	2.4 µg
Vitamin A	700 µg	900 µg
Vitamin D	400 IU	400 IU
Calcium	1,300 mg	1,300 mg
Iron	15 mg	11 mg
Zinc	9 mg	11 mg
Magnesium	420 mg	420 mg
Copper	890 µg	890 µg

Sources: Adapted from Priego, P. Special nutritional requirements in children and adolescents undergoing bariatric surgery. In Ruiz-Tovar, J. (Ed.). *Nutrition and Bariatric Surgery*. Elsevier, 2021:187–198. ISBN: 978-0-12-822922-4; and Fullmer, M. A., et al. Nutritional strategy for adolescents undergoing bariatric surgery: Report of a working group of the nutrition committee of the NASPGHAN/NACHRI. *JPGN*. 2012; 54:125–135.

The short- and long-term success following metabolic and bariatric surgery are promising, however up to 20 percent of youths may not experience significant weight loss.[9] Data from U.S. bariatric surgery centers suggests that at 3 years' post-surgery, mean weight was decreased by 27 percent (28 percent reduction after gastric bypass and 26 percent reduction after sleeve gastrectomy).[11] Almost all (95 percent) of teens had remission of type 2 diabetes, 86 percent had returned to normal kidney function, 76 percent had remission of prediabetes, 74 percent achieved normal blood pressure, and 66 percent had remission of dyslipidemia.[11] It is important to note that more than half (57 percent) of teens had hypoferritinemia and 13 percent had required additional intra-abdominal surgeries.

Effective Approaches to Obesity Prevention and Treatment

Concern about the possibility that obesity prevention messages may increase the risk of eating disorders has grown in the past decade.[12] Much of this concern arises from the focus on trying to achieve an "ideal" or specific weight and how this focus intersects with aspects of social development (extreme peer pressure) and physical development (rapid changes in body size, shape, and composition) that are hallmarks of adolescence. The use of weight-inclusive rather than weight-normative intervention approaches and language when providing MI or discussing weight-related topics with adolescents and their families may help to reduce this risk (Table 15.3).[13]

Weight-normative approaches to weight management, which emphasize weight status and weight loss as the definition of health and success, have been the most common interventions used. Such interventions have been largely unsuccessful in the long term, with the majority of people regaining lost weight. Weight cycling, repeated weight loss and weight gain cycles, may occur as a result. This can lead to poor physical and emotional outcomes, and may exacerbate weight stigma and body dissatisfaction.[13] Weight stigma has been reported not only in school or social settings for youths, but also in health-care settings.[14] Individuals that experience weight stigma are more likely to experience poor health outcomes, such as increased risk of hypertension, binge eating behaviors, low self-esteem, and depression.[14]

A weight-inclusive approach to obesity prevention focuses on the overall health of an individual rather than on a specific BMI or weight category, body size, or body composition.[13] The focus is more holistic, focusing on improving behaviors known to reduce risk of a variety of chronic diseases (including obesity) such as healthy eating and being physically active. Health-care providers who utilize weight-inclusive approaches do not have to totally

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Table 15.3 Principles of weight-inclusive approaches to obesity prevention and treatment in youths

Accept that bodies naturally occur in a variety of sizes and shapes. Commit to providing consistent care to all patients regardless of their physical appearance or experiences (success and failures) with weight management strategies.
Create and provide holistic weight management and health-care services. Interventions should focus on mastering health-promoting behaviors rather than on achieving a specific body weight or BMI.
Help clients learn to monitor their own health and well-being and to correlate changes in how their body feels and functions with behavioral changes they have mastered.
Seek out best practices and clinical guidelines that incorporate weight-inclusive approaches to health and weight. Incorporate proven successful weight-inclusive principles and intervention methods into existing health-care programs and services.
Engage in policy, systems and environmental change strategies that create healthy environments where youth live, learn, and play. Communities should make healthy eating and active living possible for all youth. Work closely with local and/or state public health, parks and recreation, planning and human services departments to assure that health is integrated into all policies and programs.
Use non-judgmental, weight-inclusive language and conversations when discussing health and weight with adolescents and their families. Ask adolescents how they prefer to talk about their bodies and their weight status.

Source: Adapted from Reference 13.

avoid talking about body weight or BMI; however, they can do so in a more neutral way. Rather than telling a client what their ideal weight or BMI range would be, a weight-inclusive provider would tell the client what their weight or BMI value is. Such a provider would ask the teen what concerns they have (if any) about their health, weight, or body shape. Weight-inclusive providers also ask how an adolescent feels about their body and their health and whether they have experienced changes in how they feel over time. Answers to these questions not only help health-care providers understand the concerns of the teen, but these conversations also provide clues about the language teens use when talking about their own weight and bodies. Asking similar questions of parents can help health-care practitioners identify possible weight stigma that parents may direct toward their teens. This can be useful for starting conversations with families about support health behavior goals that adolescents may set for themselves.

15.2 Dieting, Disordered Eating, and Eating Disorders

Eating concerns and disorders lie on a continuum ranging from mild dissatisfaction with one's body shape to serious eating disorders such as anorexia nervosa, bulimia nervosa, and binge-eating disorder. Along the continuum, between these endpoints, lie normative dieting behaviors and more severe disordered eating behaviors such as self-induced vomiting and binge eating (Figure 15.3). Although engagement in anorexic behaviors and unhealthy dieting may not be frequent or intense enough to meet the formal criteria for being defined as an eating disorder, these behaviors may negatively impact health and may lead to the development of more severe eating disorders. All eating disorders present a serious public health concern in light of their prevalence and their potentially adverse effects on growth, psychosocial development, and physical health outcome.

Dieting behaviors among adolescents, particularly among adolescent girls, has long been a concern. It has been estimated that more than 60 percent of adolescent females and more than 30 percent of adolescent males have dieted to lose weight.[16] Dieting may be more prevalent among Hispanic female adolescents (66 percent) than White female adolescents (60 percent), with Black female adolescents dieting at a lower, but still high, rate (54 percent).[15] Nearly half of Hispanic male adolescents (40 percent) reported dieting, compared to 29 percent of White and 26 percent of Black male adolescents.[15] The prevalence of dieting drops slightly with age among male adolescents but increases with age among female adolescents. Dieting remains a significant issue for adolescents of all ages, races, and ethnicities, which persists into adulthood.

Dieting and the use of unhealthy weight-control behaviors may place adolescents at increased likelihood of being overweight in the future.[13] Dieting behaviors among youths are of concern in that they are often used by youths who are not overweight. Furthermore, unhealthful dieting behaviors in which meals are skipped, energy intake is severely restricted, or entire food groups are lacking are common. Dieting behaviors have been found to be associated with inadequate intakes of essential nutrients, particularly when an entire food group or category is avoided. Restricting behaviors (e.g., avoiding all sweet-tasting foods) can lead adolescents to experience hunger or cravings for specific foods, which may place them at risk for binge-eating episodes. Finally, dieting behaviors may be

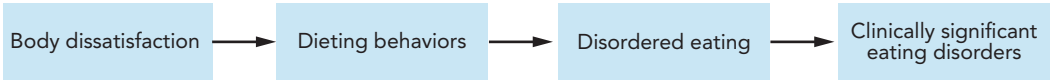


Figure 15.3 The continuum of weight-related concerns and disorders.

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indicative of increased risk for subsequent development of obesity and/or eating disorders.[13] Therefore, dieting should not be viewed as a normative, acceptable, or low-risk behavior.

During adolescence, body image and self-esteem tend to be closely intertwined; therefore, body-image concerns should be addressed and not simply viewed as acceptable and normal. Furthermore, body dissatisfaction is a main contributing factor to dieting behaviors, disordered eating behaviors, and clinical eating disorders.[13,14,16] Body dissatisfaction appears to increase dramatically following the body-weight increase that normally occurs in female adolescents around the time of menarche and remains a significant concern for female teens for the next 1–2 years. Binge eating and/or purging has been found to occur within 6–12 months of menarchial weight changes.[17] Although actual weight status is directly associated with perceived weight status, a considerable number of teens who are not overweight perceived of themselves as overweight, particularly around the time of puberty. In working with those who are overweight or obese and who express body dissatisfaction, health professionals are challenged to help them improve their body image while simultaneously working toward weight control. All adolescents, including overweight or obese youth, should be encouraged to appreciate the positive aspects of their bodies. Weight-inclusive approaches are recommended.

Disordered Eating Behaviors and Eating Disorders

Some adolescents engage in restricting or binge/purge eating behaviors, but with less frequency or intensity than required for a formal diagnosis of an eating disorder. Behaviors typically considered in this category include self-induced vomiting; fasting or extremely restrictive dieting; binge eating; compensatory physical activity; and the use of laxatives, diuretics, or diet pills. The heterogeneity of these behaviors makes it more difficult to estimate their prevalence. Data from the Youth Risk Behavior Survey (YRBS) show that 13 percent of adolescents had gone for 24 hours or longer without eating (fasting) as a means of losing weight.[15] Fasting was more commonly reported among female adolescents (19 percent) than among male adolescents (7 percent). Eighteen percent of White female adolescents reported fasting to lose weight, compared to 17 percent of Black and 23 percent of Hispanic female adolescents; rates are lower among males with 6 percent of White and 10 percent of Hispanic and Black male adolescents reporting fasting.

Binge eating rates among U.S. and Canadian adolescents and young adults have been estimated to fall between 3 and 17 percent. Laxative use for weight-loss purposes has been estimated at up to 9 percent, with diuretic use reported by up to 3 percent of teens and young adults.[18,19] The prevalence of self-induced vomiting has been estimated at 2 to 8 percent. Data on compensatory exercise, or exercise for the purpose of purging calories eaten rather than for health benefits, is difficult to find. Adolescents who report more than 60 minutes of physical activity per day in the absence of training for specific athletic events should be carefully assessed for the purpose of excessive exercise. Teens who work out until they have "burned off" all of the calories eaten that day should be considered potentially engaging in purging behaviors.

An awareness of the prevalence of eating disorders is critical in effective planning for interventions aimed at their treatment and prevention. Conditions prevalent among youths, such as disordered eating behaviors and obesity, warrant interventions such as community-based and school-based programs that have the potential to reach large numbers of youths. The small, but growing, percentage of the adolescent population affected by eating disorders requires more intensive individual or small-group interventions. Estimates as to the prevalence of each of the eating disorders on the continuum are presented in Table 15.4.

Anorexia

Anorexia nervosa (AN) and its impact on morbidity and mortality make it the most severe condition on the continuum of eating disorders. Up to 2 percent of individuals will develop AN, with most onset occurring during adolescence.[21] While AN presents more frequently among females than among males, increasing trends have been noted among males.

Characteristics of AN include preoccupation with food, self-starvation, and strong fears of being fat.[22] An adolescent may begin with dieting behaviors due to social pressures to be thin, weight-stigmatizing comments, or as a

Table 15.4 Estimated prevalence and brief description of weight-related concerns/disorders among adolescents

Disorder	Estimated Prevalence
Anorexia nervosa	Approximately 0.2–1.0% of female adolescents and young women.
Bulimia nervosa	Approximately 1–3% of female adolescents and young women.
Binge-eating	Estimated 30% of population currently dieting; 2% of general population.
Disordered eating behaviors	Estimated 10–20% of adolescents, although estimates vary.
Dieting behaviors	Estimates vary; they range from about 44% of female adolescents, 15% of male adolescents, to 50–65% of all female adolescents attempting to lose weight.
Body dissatisfaction	Estimates vary in accordance with type of measurement used and age, gender, and ethnicity of population; approximately 60% of girls and 35% of boys are not satisfied with their weight.

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result of their discomfort with the normal pubescent weight gain. Weight loss may result in adolescents feeling more in control of their body or other aspects of their life, which further reinforces the restricting behavior. If the weight loss and accompanying body-image and self-esteem issues are not addressed early on, AN may develop. Diagnostic criteria for AN are shown in Table 15.5. Key features of AN are refusal to maintain body weight over a minimal normal weight for age and height; intense fear of gaining weight or becoming fat, even though underweight; a distorted body image; and amenorrhea (in females). There is also a diagnosis of Other Specified Feeding and Eating Disorders, which includes a normal weight AN subtype.[21]

The two subtypes of AN are restricting and non-restricting. In the restricting subtype, the individual does not regularly engage in binge-eating or purging behaviors. The non-restricting subtype exhibits regular episodes of binge-eating and purging behaviors. However, both subtypes present with a refusal to maintain a minimally normal body weight, which differentiates them from other types of eating disorders.

The mortality rate for AN is estimated at up to 5 percent, which is the highest mortality rate of all psychiatric conditions.[21,22] Reasons for fatality from anorexia include a weakened immune system due to undernutrition, gastric ruptures, cardiac arrhythmias, heart failure, and suicide.

Table 15.5 Diagnostic criteria for anorexia nervosa

• Refusal to maintain body weight at or above a minimally normal weight for age and height (e.g., weight loss leading to maintenance of body weight less than minimally normal weight in adults; or failure to make expected weight gain during period of growth, leading to body weight less than minimally normal weight)
• Intense fear of gaining weight or becoming fat, even though underweight
• Disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight
• Amenorrhea in postmenarchial women; that is, the absence of at least three consecutive menstrual cycles (a woman is considered to have amenorrhea if her menstrual periods occur only following hormone/estrogen administration)
Restricting Type
• During the episode of anorexia nervosa, the person has not regularly engaged in binge eating or purging behavior (i.e., self-induced vomiting or the misuse of laxatives, diuretics, or enemas)
Binge-Eating/Purging Type
• During the episode of anorexia nervosa, the person has regularly engaged in binge-eating or purging behavior (i.e., self-induced vomiting or the misuse of laxatives, diuretics, or enemas)

Source: Adapted from the American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders, Fifth Ed.* Arlington, VA, 2013, American Psychiatric Association.

The adolescent or the family may deny the condition, which delays the diagnosis and treatment, resulting in a poorer prognosis for recovery. Early recognition of possible signs of AN and seeking out professional help significantly affect the time and intensity of treatment and improve chances for a successful recovery. Full recovery rates are estimated at less than 50 percent of individuals with anorexia nervosa; 33 percent show improvements; and 20 percent are chronically affected by this mental illness.[23,24]

Bulimia

Bulimia nervosa (BN) is an eating disorder characterized by the consumption of large amounts of food with subsequent purging by self-induced vomiting, laxative or diuretic abuse, enemas, and/or obsessive exercising.[22] While AN is characterized by severe weight loss, BN may show weight maintenance or extreme weight fluctuations due to alternating binges and fasts. In some individuals, AN and BN overlap. Estimates of BN among youths range from 1.0 to 3.0 percent.[21,22] As with AN, it is more common among female adolescents, but diagnosis rates are growing among male adolescents.

Diagnostic criteria for BN are shown in Table 15.6. Key features of BN include recurrent episodes of binge eating (rapid consumption of a large amount of food in a discrete period of time), a feeling of lack of control over eating during the binge, some form of purging food and calories from the body, and a persistent over-concern with body shape and weight.[21,22] There are two categories of BN: purging and non-purging. Individuals with the purging subtype of BN regularly engage in self-induced

Table 15.6 Diagnostic criteria for bulimia nervosa

A. Recurrent episodes of binge eating. An episode of binge eating is characterized by both of the following: • Eating, in a discrete period of time (e.g., within any 2-hour period), an amount of food that is definitely larger than most people would eat during a similar period of time and under similar circumstances. • A sense of lack of control over eating during the episode (e.g., a feeling that one cannot stop eating or control what or how much one is eating).
B. Recurrent inappropriate compensatory behavior in order to prevent weight gain, such as self-induced vomiting; misuse of laxatives, diuretics, enemas, or other medications; fasting; or excessive exercise.
C. The binge eating and inappropriate compensatory behaviors both occur, on average, at least once a week for 3 months.
D. Self-evaluation is unduly influenced by body shape and weight.
E. The disturbance does not occur exclusively during episodes of anorexia nervosa.

Source: Adapted from the American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders,* Fifth Ed. Arlington, VA, 2013, American Psychiatric Association.

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vomiting and/or the use of laxatives, diuretics, or enemas to purge calories from the body. Individuals with the non-purging subtype may fast in between binge episodes and utilize compensatory exercise as a means of compensating for caloric intake. People with BN can be overweight, underweight, or of average weight for their height and body frame. BN may be preceded by a history of dieting or restrictive eating, which are thought to contribute to the binge–purge cycle. The Other Specified Feeding and Eating Disorders diagnostic category also includes subthreshold FN and purging disorder subcategories.[21,22]

Mortality for BN is lower than for AN, estimated at approximately 2–3 percent.[21,22] Recovery rates for BN are estimated at 48 percent for full recovery, 26 percent for improvement, and 26 percent for chronicity.[23,24] Early diagnosis and treatment and less severe behaviors are associated with better outcomes for BN, while having a comorbid psychological condition such as borderline personality disorder, anxiety, or alcohol abuse is associated with poorer outcomes.

Binge-eating Disorder

Binge-eating disorder (BED) is a condition in which an individual engages in eating large amounts of food and feels that these eating episodes are not within one's control.[21,22] BED is defined by recurrent episodes of binge eating at least one day a week for at least three months (Table 15.7). In addition, the person feels a subjective sense of a loss of control over binge eating, which is indicated by the presence of three of the following five criteria: eating rapidly, eating when not physically hungry, eating when alone, eating until uncomfortably full, and feeling self-disgust about bingeing. BED differs from bulimia nervosa in that binge eating is not followed by compensatory behaviors such as self-induced vomiting, as occurs in bulimia nervosa.

The prevalence of BED is estimated at about 3 percent but episodes of binge eating and loss of control over eating have been estimated at 20 percent to 30 percent.[21,22,25] BED appears to be more prevalent among overweight or obese clinical populations (30 percent) than among community samples (5 percent of female adolescents and 3 percent of male adolescents).[21,25] Studies on adolescents that assess the prevalence of binge eating include a few that document prevalence rates of BED. Age of onset of BED can be early in childhood but diagnosis often occurs in adolescence or early adulthood.

binge-eating disorder (BED) An eating disorder characterized by periodic binge eating, which normally is not followed by purging. People must experience eating binges twice a week on average for over 6 months to qualify for this diagnosis.

Table 15.7 Diagnostic criteria for binge-eating disorder

A. Recurrent episodes of binge eating. An episode of binge eating is characterized by both of the following: • Eating, in a discrete period of time (e.g., within any 2-hour period), an amount of food that is definitely larger than most people would eat in a similar period of time and under similar circumstances. • A sense of lack of control over eating during the episode (e.g., a feeling that one cannot stop eating or control what or how much one is eating).
B. The binge-eating episodes are associated with three (or more) of the following: • Eating much more rapidly than normal • Eating until feeling uncomfortably full • Eating large amounts of food when not feeling physically hungry • Eating alone because of being embarrassed by how much one is eating • Feeling disgusted with oneself, depressed, or guilty after overeating • Experiencing marked distress regarding binge eating • Occurring, on average, at least 1 day a week for 3 months
C. The method of determining frequency differs from that used for bulimia nervosa; future research should address whether the preferred method of setting a frequency threshold is counting the number of days on which binges occur or counting the number of episodes of binge eating.
D. The binge eating is not associated with the regular use of inappropriate compensatory behaviors (e.g., purging, fasting, excessive exercise) and does not occur exclusively during the course of anorexia nervosa or bulimia nervosa.

Source: Adapted from the American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders,* Fifth Ed. Arlington, VA, 2013, American Psychiatric Association.

Dieting may be a risk factor for BED; however, 35–55 percent of women may experience binging before dieting.[18,19] Women who report dieting before bingeing are more likely to have experienced sexual or physical abuse, which may lead to feelings of loss of control and the desire to participate in restricting behaviors to regain a sense of control. Women who experienced stressful situations, such as the death of someone close to them, were more likely to report bingeing prior to dieting, consistent with an emotional eating response.

Causes of Disordered Eating and Eating Disorders

The causes of eating disorders are multifactorial including social norms emphasizing thinness, being teased about one's weight, familial relations (e.g., chaotic lifestyles, lack of boundaries between family members, poor patterns of communication), physical and sexual abuse experiences, personal body shape and size, body image, and self-esteem (Table 15.8). A genetic component to eating disorders has

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Table 15.8 Screening elements and warning signs for individuals with eating disorders

Screening	Warning Signs
Body image and weight history	Distorted body image
	Extreme dissatisfaction with body shape or size
	Profound fear of gaining weight or becoming fat
	Unexplained weight change or fluctuations greater than 10 lb
Eating and related behaviors	Very low caloric intake; avoidance of fatty foods
	Poor appetite; frequent bloating
	Difficulty eating in front of others
	Chronic dieting despite not being overweight
	Binge-eating episodes
	Self-induced vomiting; laxative or diuretic use
Meal patterns	Fasting or frequent meal skipping to lose weight
	Erratic meal pattern with wide variations in caloric intake
Physical activity	Participation in physical activity with weight or size requirement (e.g., gymnastics, wrestling, ballet)
	Overtraining or "compulsive" attitude about physical activity
Psychosocial assessment	Depression
	Constant thoughts about food or weight
	Pressure from others to be a certain shape or size
	History of physical or sexual abuse or other traumatizing life event
Health history	Secondary amenorrhea or irregular menses
	Fainting episodes or frequent light-headedness
	Constipation or diarrhea unexplained by other causes
Physical examination	BMI < 5th percentile
	Varying heart rate, decreased blood pressure after arising suddenly
	Hypothermia; cold intolerance
	Loss of muscle mass
	Tooth enamel demineralization

Sources: Based on Herpetz-Dahlmann, B. Adolescent eating disorders: Definitions, symptomatology, epidemiology and comorbidity. *Child Adolesc Psychiatr Clin N Am.* 2009; 18(1):31–47; *American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders, Fifth Ed.* Arlington, VA: American Psychiatric Association, 2013; Mazzeo, S. E., & Bulik, C. M. Environmental and genetic risk factors for eating disorders: What the clinician needs to know. *Child Adolesc Psychiatr Clin N Am.* 2008; 18:67–82; Shaw, H., Stice, E., & Becker, C. B. Preventing eating disorders. *Child Adolesc Psychiatr Clin N Am.* 2008; 18:199–207.

been proposed in response to studies that have shown a 7- to 12-fold increased risk of diagnosis of these disorders within families.[21] Twin studies suggest a heritability of between 28 percent and 84 percent for eating disorders.[21] These factors do not operate in isolation, but rather, an interaction between genetics and environmental risk factors may be necessary to increase an adolescent's risk for engaging in potentially harmful eating and dieting behaviors. Weight-based teasing or stigmatization during youth may serve as a tipping point for the development of eating disorders during youth.

In considering the causes of eating issues, it is essential to realize that different pathways may lead to weight-related disorders in different adolescents. For some adolescents, family issues may be major factors, while for others social norms or weight-based teasing may be the key factors leading to the onset of a condition. Furthermore, different conditions tend to be influenced by different factors. Potential contributory factors for eating disorders can be categorized into environmental, familial, interpersonal, and personal domains.

An understanding of the causes of eating disorders is essential to the development of effective interventions aimed at their treatment and prevention. For services provided to individual adolescents, clinical providers need to allow time to assess the specific factors leading to the onset of the eating disorder for each particular adolescent. Assessment of these factors may focus heavily on personal and familial risk factors. In developing prevention programs that will reach groups of adolescents, it is more feasible to identify and address factors that may be contributing to the onset of weight-related behaviors and conditions for a broad sector of the targeted population, such as school environments, peer group norms and behaviors, and media influences. Although not all factors may be addressed within one intervention, it is important to be aware of the broad range of factors coming into play and the interactions among them to develop comprehensive eating disorder prevention and treatment programs.

The complex causes of eating disorders and their potentially life-threatening psychosocial, physical, and behavioral consequences highlight the need for a multidisciplinary treatment approach. The health-care team caring for an adolescent with an eating disorder will usually include a physician, dietitian, nurse, psychologist and/or psychiatrist, and often a social worker.[18,24] The role of the dietitian is paramount to the treatment of eating disorders at the stages of assessment, treatment, and maintenance. Initially, an adolescent may be more willing to discuss their concerns with a dietitian than with a psychologist or other health-care provider.

Eating Disorders Treatment

The treatment of eating disorders may take many forms including outpatient care, partial hospitalization, residential treatment programs and inpatient hospitalization treatment.[21] Individuals with eating disorders who are medically and psychologically stable are generally treated through outpatient programs. The frequency of contact with the health-care

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team is usually weekly, but it may be more frequent, if required. Day treatment programs, often referred to as partial-inpatient programs, may be recommended for individuals who require daily contact with the health-care team and whose body weight is sufficient to remain treated as an outpatient. Day treatment programs may vary in the number of weekly visits from 3 to 7 days per week, depending on the facility and the client. Residential programs are indicated when an individual requires daily treatment and monitoring, but is medically stable enough to not require hospitalization. Inpatient programs are required for individuals with life-threatening comorbidities, unstable medical or psychological status, or severely low body weight. The criteria for inpatient care of adolescents are listed in Table 15.9. The disruptions caused by the COVID pandemic, including school closures, general anxiety, increased amount of engagement with social media, and heightened physical self-awareness as a result of being on camera during distance learning, has led to a dramatic increase in the number of teens being diagnosed with, and treated for, eating disorders in the past 2 years. Studies have suggested a 60 percent increase in the onset of eating disorders, with newly diagnosed cases presenting with greater deficits in body weight and more cardiac symptoms present.[20] This resulted in a higher rate of inpatient treatment.

The goal of eating disorder treatment programs is to restore a healthy body weight, to improve social and emotional well-being, and to normalize eating–related thoughts and behaviors. While programs vary, the core components of any eating-disorder treatment program include:[21,23,24]

- Treatment of medical and psychological comorbidities
- Restoration of body weight to a healthy level
- Nutrition education and counseling to normalize food-related thoughts and beliefs and to reduce anxiety over eating in public
- Individualized psychotherapy to improve social well-being and emotional health, including cognitive behavioral therapy
- Family therapy to improve communication and family function
- Group therapy

Table 15.9 Suggested criteria for inpatient treatment of eating disorders

Medical Criteria	Psychosocial Criteria
Failure to thrive (BMI <3rd percentile)	Social isolation
Rapid and dramatic weight loss	Depression
Very low caloric intake	Obsessive-compulsive disorder
Refusal to eat or drink	Suicidal thoughts or tendencies
Hypokalemia	Lack of parental support
Alkalosis	Poor family communication and dynamics
Bradycardia	Poor response to outpatient or day treatment
Pancreatic dysfunction	
Liver dysfunction	

Source: Based on Herpetz-Dahlmann, B., & Slaback-Andrae, H. Overview of treatment modalities in adolescent anorexia nervosa. *Child Adolesc Psychiatr Clin N Am.* 2008; 18:131–145.

During treatment, a major role of the dietitian is to help the adolescent normalize thoughts around food, establish healthy eating patterns, and feel comfortable with these changes. Some of the key goals of the nutritional care include the following:

- Thoroughly assess dietary intake and adequacy
- Recommend nutrition-related therapeutic interventions based on nutrition-assessment data and any co-morbid conditions that may exist or arise
- Provide counseling to client to establish a regular pattern of nutritionally balanced meals and snacks
- Monitor dietary intake and physical activity levels to determine adequate but not excessive levels of energy intake or physical activity, with the goal of reaching and maintaining a healthy body weight
- Counsel clients to consume adequate dietary fat, fluids, and fiber intake to promote satiety
- Provide counseling in conjunction with the psychologist or other mental health-care provider on strategies to help clients avoid dieting behaviors and excessive exercise or other methods of purging
- Assist clients with strategies to gradually include formerly forbidden foods into the diet, which may include role-modeling appropriate food intake at mealtimes, arranging for groups of clients to practice eating out at restaurants, and assisting clients in preparing meals
- Periodically evaluate effectiveness of interventions
- Monitor client nutritional status, adjusting diet-related interventions as needed

For some adolescents, denial of the condition or a lack of motivation for change makes nutrition counseling quite challenging. It is important for the nutritionist to work in close conjunction with other members of the health team to ensure that roles of different members of the team are clearly defined. Information provided to the adolescent and their family needs to be consistent across all team members.

The high prevalence of eating disorders and their potentially harmful consequences point to a need for interventions aimed at their prevention. One of the most pressing current public health issues that needs to be addressed concerns the prevention of eating disorders described in

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previous sections and the prevention of obesity. Even the prevention of a small percentage of these conditions, at a population level, returns huge benefits in terms of reducing physical, emotional, and financial burdens.

Prevention of Eating Disorders In the development of interventions aimed at the prevention of eating disorders, it is essential to address factors that contribute to the onset of these conditions for a large proportion of the targeted population, factors that are potentially modifiable, and factors suitable for addressing within the designated setting. For example, media awareness and advocacy has been suggested as a suitable approach toward preventing eating concerns and disorders. Participants may learn about how the media influence one's body image and about techniques used within the media to improve the appearance of models, and then take action toward making changes in the media. This approach is suitable in that media influences, and the internalization of media messages, may contribute to weight concerns among a large sector of the adolescent population. These adolescent perceptions are potentially modifiable and suitable for addressing within clinical, community, and school-based settings where interventions may be implemented; intervention on body image may reduce short-term risk for disordered restrictive eating.[26] Interventions related to improving depressive symptoms and increasing self-esteem, with a strong focus on family, has been suggested as key to reducing long-term risk for disordered eating.[21,23,24,26]

Any efforts toward prevention first must consider the target audience. An important question is whether to direct interventions to all adolescents or only to adolescents at increased risk for eating disorders. Reasons for providing interventions for all adolescents include the high prevalence of eating concerns among adolescents, difficulties inherent in identifying and targeting high-risk individuals, and the advantages of developing positive social norms regarding eating issues within the peer group. Taking a more targeted approach offers the advantages of better use of limited resources, more intensive interventions, and interventions developed for specific high-risk groups (e.g., dancers, elite athletes, youth with diabetes, or overweight or obese teens). In order to be most effective at preventing eating disorders, both types of interventions seem necessary; more general approaches address the issues of the general adolescent population, while more refined approaches can better meet the needs of specific high-risk groups.

Prevention interventions may be implemented within clinical, community, and school-based settings that serve adolescents. A meta-analysis of eating-disorder prevention programs suggests that more than half of published eating-disorder prevention programs reduced at least one risk factor for disordered eating, and 29 percent reduced the severity of disordered eating among youth.[27] Programs that focused on changing weight-related attitudes of youth and promoted healthy weight-control strategies were found to be the most effective, with effects lasting up to 2 years. Other characteristics of successful eating-disorder prevention programs included:

- Selective targeting of high-risk groups rather than all youth
- Programs targeting adolescents >15 years of age
- Programs with information provided by trained interventionists rather than counselors, teachers, or health-care providers
- Programs that included multiple sessions rather than a single encounter
- Integrated interactive learning (role-playing, computer technology, etc.) rather than providing only didactic learning experiences

Most eating-disorder prevention programs have focused on female adolescents. There is a need to develop prevention programs for male adolescents as well, especially those who exhibit a high concern about muscularity or thinness.

15.3 Nutrition for Adolescent Athletes

More than half (57 percent) of U.S. adolescents report playing on one or more organized sports teams through their school or a community organization.[28] Participation is higher among male adolescents than female adolescents (60 percent versus 55 percent). White (62 percent) students report participation in organized sports more often than do Black (56 percent) or Hispanic students (52 percent).

High levels of physical activity, combined with growth and development, increase adolescents' needs for energy, protein, and select vitamins and minerals. Participation in competitive sports often means an adolescent will participate in intense training and competition during an athletic season. If the athlete competes in several sports, energy and nutrient needs will remain relatively stable throughout the year. If an athlete participates in only one sport and does not maintain a training routine off-season, energy and nutrient needs may fluctuate based on the timing of the sports season. Therefore, adolescents must be assessed for seasonal and yearly physical activity when energy and nutrient needs are determined.

The energy and nutrient needs of adolescent athletes vary widely. Many of the recommendations available are based on needs of young adult athletes or are extrapolated from usual nutrient needs of adolescents. The best method of assessing the nutrient needs of athletes is to begin with general dietary needs based on Sexual

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Maturation Rating (SMR, refer to Chapter 14), adding additional allowances based on the unique needs of the individual and the intensity of physical activity they engage in. In order to assess individual nutrient needs, health-care professionals must gather information such as the following:

- What sport(s) does the adolescent engage in, and what is the duration of the competition season?
- What is the level of competition of the adolescent? Is participation recreational, competitive, or elite?
- What kind of training does the adolescent engage in? The method(s), intensity, and duration of training activities should be noted.
- Does the athlete typically sweat profusely or lose body weight during competition? Weighing before and after practice and competition is a good idea, especially during outdoor activities in hot and humid weather or in cases where movement may be sporadic but heavy gear may cause sweating (e.g., hockey goalies).
- Does the athlete follow a special diet or take supplements to improve athletic performance? The type, amount, and frequency of supplement use should be noted and counseling provided as necessary.

General energy and protein needs are discussed in Chapter 14. These guidelines should provide the foundation for calculating protein and energy needs for athletes. Competitive athletes may require 500–1,500 additional calories per day to meet their energy needs. Athletes and their parents should be encouraged to monitor weight stability throughout the sports season. During the season, particularly during intense training phases or at the beginning of a season, athletes should weigh themselves before and after practice and sporting events. Any change in body weight during the activity signals a loss of body water, which could lead to dehydration. Any weight loss that is not transient (transient losses are often due to dehydration) signifies that the caloric intake is inadequate to support growth and development. A thorough assessment of energy and protein intakes, accompanied by measurements of body composition, should be taken when unexpected weight loss occurs. Protein should supply no more than 30 percent of calories in the diet, to allow adequate energy intake from fat and carbohydrates. Groups at risk for inadequate intake would include athletes who follow restrictive diets to maintain a particular weight. When the main sources of protein are plant-based, iron status should be assessed in female athletes because plant-based sources may be lower and/or less bioavailable.

Dietary intakes of athletes should follow the MyPlate recommendations, with the realization that the increased energy needs of athletes may require them to consume the upper limit of food-group recommendations. Athletes should be encouraged to eat a pre-event meal at least 2 to 3 hours prior to exercise; eating too close to exercise may lead to indigestion and physical discomfort.[29,30] Table 15.10 provides an overview of meal and snack recommendations for adolescent athletes. Foods that are high in fat, protein, and/or dietary fiber should be avoided for at least four hours prior to exercise, because they take longer to digest and may cause physical discomfort during exercise. Protein and fat also displace complex carbohydrates, which are the most readily available source of energy during athletic events. Post-event meals should contain approximately 400–600 cal and should comprise high-carbohydrate foods and adequate amounts of non-caffeinated fluids.[29,30]

Calcium Calcium intakes have been shown to be below the DRIs in a significant proportion of adolescents, especially females. Athletes' increased risk for bone fractures makes adequate calcium intake extremely important.[29,30] Although the mechanism responsible for this tendency has not been identified, female adolescent athletes with low calcium consumption appear to be the highest-risk group of all adolescents for bone fractures, and they therefore should make every effort to consume adequate calcium in their diets. Teen athletes who cannot or will not consume calcium from dietary sources should be counseled to take a daily calcium supplement that meets their daily requirements.

Table 15.10 Recommendations for food and beverage prior to sports events

Meal/Snack Composition	Timing	Examples of Recommended Foods and Beverages
Snack with 15–20 g CHO and <5% of energy from fat	30–60 minutes prior to event	Cereal bar, water, and ½ cup juice
Light meal with 30–40 g CHO and 5–15% of energy from fat	2–4 hours before event	Turkey and cheese sandwich, ½ cup grapes, water, 1 cup lemonade
Full meal with 50–60 g CHO and 15–25% of energy from fat	4–5 hours prior to event	Roasted chicken, mashed potatoes, ½ cup carrots, small banana, and water OR peanut butter and jelly sandwich, 1 cup low-fat milk, 1 orange, water

Source: Based on Holt, K., Wooldridge, N., Story, M., & Sofka, D. (Eds.). *Bright Futures Nutrition*, 3rd ed. Elk River, IL: American Academy of Pediatrics, 2011:186.

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Fluid Level and Dehydration Fluid intake is an important issue in sports nutrition for adolescents. Young adolescents and those who are prepubertal present a particular vulnerability to heat illnesses because their bodies do not regulate body temperature as well as those of older adolescents. Adolescents can become so mentally and physically involved in physical activities that they do not pay attention to physiological signals of fluid loss, such as excessive sweating and thirst. Some athletes commonly assume they do not need additional fluids if they are not actively moving all of the time during exercise. Other factors such as ambient temperature and humidity levels and weight of equipment (helmets, padding, etc.) worn or utilized during exercise also play a role. For instance, hockey goalies may not skate for great distances during a match, yet they may lose 5 or more pounds of body weight due to the weight of the padding and equipment they wear. Therefore, all athletes should be counseled to regularly consume fluids, even if they do not feel thirsty.

Table 15.11 provides recommendations for fluid intake before, during, and after strenuous physical activity. Athletes should consume 6–8 oz of fluid prior to exercise, 4–6 oz every 15–20 minutes during physical activity, and at least 8 oz of fluid following exercise.[29,30] Recommendations encourage athletes to weigh themselves periodically before and after exercise or competition to determine whether they have lost body weight. Each pound of body weight lost during an activity requires ingestion of 16 oz of fluid following the activity to maintain proper hydration. Athletes should drink no more than 16 oz of fluid each 30 minutes, however, to avoid potential side effects, such as nausea.

The type of fluid an athlete drinks may be affected more by peer pressure and mass media than by actual physiological need. Sports drinks and energy drinks are very popular among teens, even those who do not participate in sports. Data on children suggest that even though water is an economical, easily available fluid, it may not provide optimal benefits for athletes who participate in physically intense events or those of great duration.[29,30] In such events, juice diluted at a ratio of 1:2 with water, or sports drinks that contain no more than 6–8 percent carbohydrate, may allow for better hydration and physical performance. Undiluted juices, fruit drinks, carbonated beverages, energy drinks, and sports drinks that contain more than 6–8 percent carbohydrate are not recommended during exercise because they may cause gastric discomfort. Their high carbohydrate content may also alter gastric emptying. Some carbonated soft drinks and many energy drinks contain significant amounts of caffeine, which promotes diuresis.

Table 15.11 Recommendation for fluid intake during strenuous physical activity

Time	Amount of Fluids
1–2 hours prior to event	12–22 oz cool water*
10–15 minutes before event	10–20 oz cool water
During event	4–6 oz cool water every 15–20 minutes
After event	2–3 cups of cool fluid for every pound of body weight loss

*Cool water and fluids should be 50–60°F and lower than ambient temperature.

Source: Based on Holt, K., Wooldridge, N., Story, M., & Sofka, D. (Eds.). *Bright Futures Nutrition*, 3rd ed. Elk River, IL: American Academy of Pediatrics, 2011:187.

Training Diets Adolescent athletes may follow special diets or consume nutritional and non-nutritional supplements in an effort to improve physical performance and increase lean body mass. Special diets that are noted among adolescent athletes include carbohydrate-loading regimens and high-protein diets. Distance runners and other endurance athletes have long used carbohydrate loading to improve the glycogen content of muscle. It involves the manipulation of training intensity and duration, along with the carbohydrate content of meals to improve glycogen formation in muscle tissue. Carbohydrate loading is traditionally a week-long process that begins with intense training 1 week prior to competition. For the first 3 days of a carbohydrate-loading week, athletes choose low-carbohydrate foods, but continue to exercise in an attempt to deplete muscle glycogen stores. During the 3 days prior to competition, athletes rest, or exercise minimally, while consuming a high-carbohydrate diet to promote glycogen formation and storage. Many athletes follow a modified version of this regimen rather than the full traditional method.

High-protein diets may take many forms for teen athletes. In general, athletes who follow high-protein diets may consume three to four times the recommended protein intake, accompanied by a relatively low intake of carbohydrate. High-protein diets should be discouraged as pre-performance dietary regimens among athletes for several reasons. First, many dietary protein sources are also sources of total and saturated fats, which may increase lifetime risk of coronary artery disease. Second, high protein and fat intakes result in reduced carbohydrate intake and may delay digestion and absorption, limiting the amount of energy available for use during physical activity. Finally, more water is required for the breakdown of protein than for either fat or carbohydrate due to the increased water loss that accompanies the excretion of nitrogen. This factor places an athlete at increased risk for dehydration, often accompanied by a decrease in physical performance. High protein intake appears to be more effective in recovering from intense physical activity than in preparing for an event.

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Case Study 15.1 Following Ava's Medical History

Ava is a 15-year-old high school student who is active in school activities, loves to run and bike, and has a 3.95 grade point average. She has a close group of friends that she spends her free time with; her parents are very proud of her for her outstanding academic performance.

School Nurse Visit Ava is being seen at the school clinic for a sore throat and fever. The nurse takes her height (5′3″) and weight (107 lb). Ava is diagnosed with a strep throat infection and is given antibiotics.

Sports Physical Visit Ava is seen 4 months later (in early fall) by her pediatrician for a sports physical, since she is planning to join the cross-country running team. Weight at this time is 96 pounds. The physician notes that Ava seems to be tired and has lost weight since her most recent visit to the clinic. Ava replies that she has had a lot of sinus and other infections, which causes her to lose her appetite. She also notes that she has been training hard to make the cross-country team but that her training should become less intense now that she has made the team. Ava assures the physicians that she will try to eat more in the future. The physician encourages her to eat a lot of carbohydrates and protein to improve her sports performance.

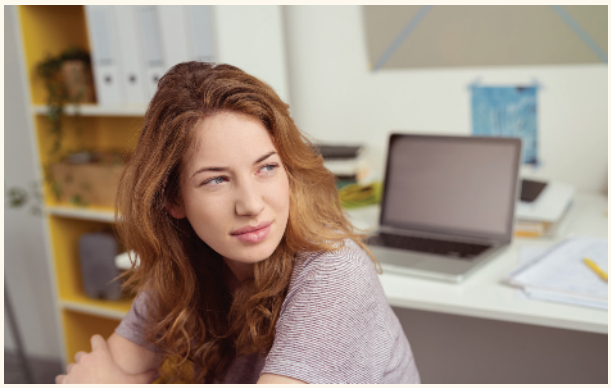
Preemployment Physical Visit Ava is seen by her family physician for a preemployment physical in early June. At this time, her weight is 91 pounds.

The physician is concerned about her weight, but Ava assures her that she looks and feels fine. The MD refers her to the outpatient clinical dietitian. During the interview with the dietitian, it is noted that Ava eats only twice a day, with many diet beverages in between these meals. The dietitian suggests that Ava increase her weight to at least 95 lb, but she refuses, stating that at this weight she would "have too much fat in her thighs" for running. When asked about the use of diet pills, laxatives, and other diet aids, Ava states that she doesn't need these because she has enough willpower to reduce her food intake on her own. She also denies vomiting after eating. When asked about her willingness to reduce her running so that she could reach a more healthful weight, Ava gets agitated. The dietitian asks Ava how she determines how much or how long she needs to run. Ava states that she runs as long as she needs to so that she can use up all of the calories she has eaten. When the dietitian suggests that this is compensatory exercise and is a form of purging, Ava becomes upset and leaves. The dietitian looks for her parents in the waiting room, and lets Ava's mother know that she thinks there may be an eating issue that the family should deal with. The mother thanks the dietitian for letting her know and leaves, as Ava has already gone to the parking lot.

The dietitian confers with the physician and her parents and sends information about eating disorders, including possible outcomes and treatment options. Three months later, the clinic is notified that Ava has fainted at gym class in school and that the hospital where she was taken has referred her for an in-patient eating disorder evaluation.

Questions

1. For the school nurse visit, what is Ava's BMI?
2. What percentile does Ava's weight fall at during the school nurse visit?
3. How would you classify Ava's weight status at the school nurse visit?
4. Calculate BMI and percentile from the sports physical visit.
5. How would you classify her weight status at the sports physical visit?
6. What advice would you give to Ava in terms of pre-event sports nutrition?
7. What advice would you give her about post-event eating?
8. Calculate BMI and percentile from the preemployment physical visit.
9. How would you classify her weight during the preemployment physical visit?
10. What eating issue would you suspect Ava has? Why?
11. What are the long-term outcomes and prognosis of this issue?



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15.4 Special Dietary Concerns Among Adolescents

Adolescence is a time during which chronic health conditions may begin to appear. While issues such as hyperlipidemia, hypertension, metabolic syndrome, and type 2 diabetes may be more common among teens with overweight or obesity, adolescents of all weights may experience these conditions. Annual physical examinations may reveal health concerns that benefit from nutrition intervention. A few of the more common conditions are discussed below.

Hyperlipidemia

Approximately one in four adolescents in the United States has an elevated cholesterol level.[28] Table 15.12 provides the classification criteria for elevated blood lipid and cardiovascular disease markers in children and adolescents. It should be noted that total and LDL cholesterol levels drop by 10–20 percent during puberty; thus, the best time to screen for hyperlipidemia is around age 10 (before the onset of puberty) or after age 17, when growth is largely completed. Youths who have family risk factors for hyperlipidemia or who are overweight or obese should undergo blood lipid and cardiovascular disease risk marker screening, but routine screening for all adolescents is not warranted.[31] Risk factors for hypercholesterolemia include a family history of cardiovascular disease or high blood cholesterol levels, cigarette smoking, overweight, hypertension, diabetes mellitus, and low level of physical activity. Early intervention among adolescents who have high cholesterol levels may reduce their risk of coronary artery diseases later in life.

The National Heart, Lung, and Blood Institute (NHLBI) has developed the CHILD 1 (Cardiovascular Health Integrated Lifestyle Diet 1) diet and nutrition guidelines, which integrate dietary approaches to prevention hypertension, hyperlipidemia, and obesity. These guidelines include the DASH dietary guidelines (Table 15.13) as well as recommendations to consume 14 g of dietary fiber per day per 1,000 kcals, limiting intake of juice to 4–6 oz per day, limiting sodium intake and choosing low-sodium foods when available, limiting fast-food meals, and encouraging daily breakfast consumption and family meals.[31]

Hypertension

Criteria for the detection and diagnosis of hypertension are shown in Table 15.14. Adolescents are considered to have pre-hypertension if blood pressure readings are ≥90th percentile but <95th percentile for age and gender, or >120/80. Hypertension is diagnosed if the average of three systolic and/or diastolic blood pressure readings exceeds the 95th percentile, based on age, sex, and height.[31] Classifications of blood pressure are based on the average of three readings:

- Normal blood pressure: <90th percentile
- Prehypertensive: >90th and <95th percentiles
- Stage 1 hypertension: >95th and <99th percentile +5 mmHg
- Stage 2 hypertension: >99th percentile +5 mmHg

Table 15.12 Recommended biochemical indices for select chronic health issues common among adolescents

	Acceptable	Borderline	Unacceptable
Fasting plasma glucose	<100 mg/dL	≥100–<126 mg/dL	≥126 mg/dL
Hemoglobin A1c	5.7%	<6.5%	≥6.5%
Fasting cholesterol			
Total cholesterol (mg/dL)	<170 (<4.4 mmol/L)	170–199 (4.4–5.15 mmol/L)	≥200 (≥5.18 mmol/L)
Non-HDL cholesterol (mg/dL)	<120 (<3.11 mmol/L)	120–144 (3.11–3.73 mmol/L)	≥145 (≥3.76 mmol/L)
LDL cholesterol (mg/dL)	<110 (<2.85 mmol/L)	110–129 (2.85–3.34 mmol/L)	≥130 (≥3.37 mmol/L)
HDL cholesterol (mg/dL)	>45 (<1.17 mmol/L)	40–45 (1.04–1.17 mmol/L)	<40 (≥1.04 mmol/L)
Triglycerides (mg/dL)	<90 (<2.33 mmol/L)	90–129 (2.33–3.34 mmol/L)	≥130 (≥3.37 mmol/L)
ALT			
Boys	25 U/L		
Girls	22 U/L		

Note: Fasting is defined as no caloric intake for at least 8 hours.

Sources: Information compiled from the following references: 1) Styne, D. M., Arslanian, S. A., Connor, E. L., et al. Pediatric obesity-assessment, treatment, and prevention: An endocrine society clinical practice guideline. *J Clin Endocrinol Metab.* 2017; 102(3):709–757. doi:10.1210/jc.2016-2573; 2) Arslanian, S., Bacha, F., Grey, M., Marcus, M. D., White, N. H., & Zeitler, P. Evaluation and management of youth-onset type 2 diabetes: A position statement by the American diabetes association. *Diabetes Care.* 2018; 41(12):2648–2668. doi:10.2337/dci18-0052; 3) U.S. Department of Health and Human Services, National Institutes of Health, National Heart, Lung and Blood Institute: Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents. Summary report. NIH Publication No 12-7486A, October 2012. Available at http://www.cdc.gov/diabetes/pubs/pdf/ndfs_2011.pdf; and 4) De Ferranti, S. D., Steinberger, J., Ameduri, R., et al. Cardiovascular risk reduction in high-risk pediatric patients: A scientific statement from the American Heart Association. *Circulation.* 2019; 139:e603–e634.

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Table 15.13 DASH eating plan to reduce hypertension and other chronic diseases: Servings per day by food group and total energy intake

Food Group	Serving Size	1,400 Kcals	1,600 Kcals	1,800 Kcals	2,000 Kcals
Grains (with whole grains the majority of choices)	1 slice bread 1 oz dry cereal ½ cup cooked rice, pasta, or cereal	6	6	6	6–8
Vegetables	1 cup raw leafy greens ½ cup raw or cooked vegetable ½ cup vegetable juice	3–4	3–4	4–5	4–5
Fruits	1 medium fruit ¼ cup dried fruit ½ cup fresh, frozen, or canned fruit ½ cup fruit juice	4	4	4–5	4–5
Milk and milk products (fat free or low-fat choices) or substitutes	1 cup milk or yogurt 1 cup soy, almond, rice, or other milk substitute 1.5 oz cheese	2–3	2–3	2–3	2–3
Lean meats, poultry, or fish	1 oz cooked meats, poultry or fish 1 egg	3–4	3–4	≤6	<6
Nuts, seeds, and legumes	⅓ cup or 1.5 oz nuts 2 Tbsp peanut or other nut butter 2 Tbsp or 0.5 oz seed ½ cup cooked legumes	3/week	3–4/week	4/week	4–5/week
Fats and oils	1 tsp margarine 1 tsp vegetable oil 1 Tbsp mayonnaise 2 Tbsp salad dressing	1	2	2–3	2–3
Sweets and added sugars	1 Tbsp sugar 1 Tbsp jelly or jam ½ cup sorbet or gelatin 1 cup lemonade	≥3 oz/week	<3 oz/week	<5 oz/week	<5 oz/week

Table 15.14 Clinical practice guidelines for management of high blood pressure in children and adolescents

Blood Pressure	Children Aged 1–13 Years	Adolescents Aged 13 Years or Older
Normal	<90th percentile	Systolic: <120 mmHg Diastolic: <80 mmHg
Elevated	>90th and <95th percentile	Systolic: 120 to 129 mmHg Diastolic: <80 mmHg
Stage 1 Hypertension	>95th and <95th percentile +12 mmHg or 130/80 to 139/89 mmHg	Systolic: 120 to 139 mmHg Diastolic: 80 to 89 mmHg
Stage 2 Hypertension	≥95th percentile +12 mmHg, or ≥140/90 mmHg	Systolic: ≥140 mmHg Diastolic: 90 mmHg

Note: Percentiles are for age, gender, and height.

Source: Flynn, J. T., Kaelber, & D. C., Baker-Smith, C. M., et al. New clinical practice guidelines for the management of high blood pressure in children and adolescents. *Hypertension*. 2017; 70(4):683–686. doi:10.1161/HYPERTENSIONAHA.117.10050.

Risk factors for hypertension among adolescents include a family history of hypertension, high dietary intake of sodium, overweight or obesity, hyperlipidemia, inactive lifestyle, and tobacco use.[31] Adolescents who display one or more of these risk factors should be routinely screened for hypertension. Nutrition counseling to decrease sodium intake; to limit fat intake to 30 percent or less of calories; and to consume adequate amounts of fruits, vegetables, whole grains, and low-fat dairy products should be provided when hypertension is diagnosed.[31] Table 15.15 outlines the dietary recommendations suggested for adolescents to promote health and reduce cardiovascular risk factors. Weight loss is recommended for adolescents who are hypertensive in the presence of

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Table 15.15 Assessment and screening recommendations for health promotion among adolescents.

Health Concern	Screening and Assessment Recommendation
Anthropometric measurements	• Measure and plot height, weight, and BMI • Review weight status with teen and family. • Teens who are overweight: Provide Step 1 counseling or refer to a registered dietitian/nutritionist for weight management counseling; schedule follow-up appointments. • Adolescents who are obese: Refer to a comprehensive weight management program for Step 2 counseling.
Family history of premature cardiovascular disease, diabetes, or obesity	• Assess for risk factors for chronic health conditions (hypertension, hyperlipidemia, diabetes) based on family history and weight status as necessary.
Blood pressure	• Review blood pressure with teen and family. • In the presence of elevated blood pressure, counsel adolescents and caregivers to follow DASH dietary pattern based on energy needs to achieve ideal body weight. • Assess changes in blood pressure at follow-up and institute management with medication as needed, if dietary changes have not been successful. • Refer teens who are overweight and obese to an appropriate weight management program.
Blood lipids	• Review blood lipid indices with teen and family. • Order blood lipid panel for overweight or obese adolescents. • Adolescents who are overweight: Provide counseling regarding DASH diet based on energy needs to achieve ideal body weight or refer to a registered dietitian/nutritionist for medical nutrition therapy. • Adolescents who are obese: Refer to a comprehensive weight management program. • Up to 2 g/day of plant sterols or stanols can be recommended for use by adolescents. • Manage dyslipidemia with medication if dietary changes and weight loss are not effective.
Dietary intake and eating behaviors	• Assess usual food intake using 24-hour recall or 3- to 7-day food diary. • Provide appropriate nutrition counseling or refer to a registered dietitian/nutritionist for medical nutrition therapy as needed.
Physical activity and sedentary activity	• Review usual daily physical and sedentary behavior patterns. • Discuss recommendation for at least 60 min/day of moderate-to-vigorous physical activity. • Emphasize the importance of limiting sedentary activity, for example, limiting screen time to no more than 2 hours/day
Diabetes	• Assess for family history of diabetes, presence of acanthosis nigricans, and symptoms consistent with diabetes among adolescents experiencing overweight or obesity. • Review fasting blood glucose levels with teens and caregivers or refer to a primary care provider for treatment and measurement of a fasting blood glucose level if laboratory data are not available. • Provide medical nutrition therapy and nutrition counseling as appropriate. • Refer teens who are experiencing overweight and obesity to a comprehensive weight management program.

Source: Adapted from U.S. Department of Health and Human Services, National Institutes of Health, National Heart, Lung and Blood Institute: Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents. Summary report. NIH Publication No 12-7486A, October 2012. Available at http://www.cdc.gov/diabetes/pubs/pdf/ndfs_2011.pdf.

overweight or obesity. If medications are prescribed, teens still must adhere to general dietary recommendations and should still be encouraged to reach and maintain a healthy weight for their height.

Diabetes and Metabolic Syndrome

It is estimated that 1 in 5 adolescents as prediabetes.[32] Impaired fasting glucose is estimated to occur in 11 percent of adolescents. Prediabetes is more common among male adolescents (23 percent) than among female adolescents (13 percent). It is also higher among teens with obesity (26 percent) than among teens who have a healthy weight BMI (16 percent). Adolescents who had prediabetes also had significantly higher LDL cholesterol, higher systolic blood pressure readings, lower insulin sensitivity and more centrally located adiposity.[32] These findings suggest that a substantial proportion of adolescents are at risk for type 2 diabetes and metabolic syndrome.

National surveillance data from 2020 suggest the rate of diagnosed diabetes in youths less than 20 years of age is 25/10,000.[33] The incidence of type 1 diabetes has increased

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in the past two decades, particularly among Hispanic and non-Hispanic Asian and Pacific Islander youths.[33] Type 2 diabetes incidence also increased during the same time period, remaining stable among White non-Hispanic youth but rising in all other groups, particularly among non-Hispanic Black teens.

Type 2 diabetes typically has few symptoms; thus, it is harder to detect in adolescents unless physical manifestations such as acanthosis nigricans are apparent. Teens with type 2 diabetes often have obesity and may have a strong family history for the disease. Older adolescents with a family history of cardiovascular disease and/or diabetes and experiencing overweight or obesity should be considered as candidates for screening for metabolic syndrome. Females who are diagnosed with polycystic ovary syndrome also benefit from screening for metabolic syndrome. Prevention strategies for type 2 diabetes and metabolic syndrome are similar and include reaching and maintaining a healthy body weight, engaging in regular physical activity, and following the DASH diet listed in Table 15.13.

Substance Use

The use of substances such as tobacco, alcohol, and recreational drugs can affect the nutritional status of adolescents. YRBS data suggest that half of adolescents report having used electronic vaping products, with one-third reporting current use.[34] Six percent of teens report smoking cigarettes, 4 percent smoked cigars, and 6 percent used smokeless tobacco. Male teens were more likely to smoke cigars and use smokeless tobacco, as well as use two or more tobacco-related products. Tobacco use was lowest among non-Hispanic Black students and highest among non-Hispanic White students.[34]

Data from the YRBS suggest that 29 percent of teens report current alcohol use; 14 percent reported binge drinking (drinking five or more alcoholic drinks during one occasion) on at least 1 day during the past month.[35] Alcohol use was higher among female adolescents than male adolescents (32 percent vs 26 percent) and among White non-Hispanic (34 percent) students than among Hispanic (28 percent) or non-Hispanic Black youth (17 percent).[35] Binge drinking is also more common among female adolescents than male adolescents (15 percent vs. 13 percent), and White students (17 percent) compared to Hispanic (12 percent) and Black students (6 percent). The consumption of alcohol may replace nutritious foods and beverages in the diet, compromising nutritional status. Thiamin and other B-vitamin requirements may be higher among adolescents who frequently consume large quantities of alcohol.

According to YRBS data, illicit drug use is reported by a significant number of adolescents.[35] Twenty-two percent report current marijuana use and 7 percent report prescription opioid misuse.[35] Illicit drug use may alter dietary intake patterns through influences on appetite and metabolism as well as dietary choices made while under the influence of these substances. In addition, for older adolescents who are financially independent, money used to purchase alcohol and illicit substances may reduce the amount of money available to purchase food and pay for other daily living expenses, thus increasing the risk of food insecurity and/or homelessness.

Data on the effects of substance use on eating behaviors have focused largely on the risk for disordered eating behaviors, particularly on BN and BED. Disordered eating is seen more frequently among female adolescents who report smoking cigarettes, drinking alcohol, and using inhalants.[36] Among male adolescents, the use of marijuana, steroids, and inhalants was related to higher risk for disordered eating. It is believed that substance use may result in depleted stores of vitamins and minerals, including thiamin, vitamin C, and iron. Chronic ingestion of alcohol and drug use can result in a reduced appetite, leading to low dietary intakes of protein, energy, vitamins A and C, thiamin, calcium, iron, and fiber (Table 15.16).

Iron-Deficiency Anemia

Iron-deficiency anemia is the most common nutritional deficiency noted among children and adolescents. Several risk factors are associated with its development among adolescents, including rapid growth, inadequate dietary intake of iron-rich foods or foods high in vitamin C, vegan diets, calorie-restricted diets, meal skipping, participation in strenuous or endurance sports, and heavy menstrual bleeding.[1,28] The effects of iron-deficiency anemia include delayed or impaired growth and development, fatigue, increased susceptibility to infection secondary to depressed immune system function, reductions in physical performance and endurance, and increased

Table 15.16 Potential effects of substance use on nutrition status

• Appetite suppression
• Reduced nutrient intake
• Decreased nutrient bioavailability
• Increased nutrient losses/malabsorption
• Altered nutrient synthesis, activation, and utilization
• Impaired nutrient metabolism and absorption
• Increased nutrient destruction
• Higher metabolic requirements of nutrients
• Inadequate weight gain/weight loss
• Iron-deficiency anemia
• Decreased financial resources for food

Source: Reprinted with permission. Alton, I. Substance abuse during pregnancy. In Story, M.. Stang, J. (Eds.). *Nutrition and the Pregnant Adolescent: A Practical Reference Guide*. Minneapolis, MN: Center for Leadership, Education, and Training in Maternal and Child Nutrition, University of Minnesota, 2010.

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susceptibility to lead poisoning. Pregnant teens that are iron deficient in the early stages of gestation are at increased risk of preterm delivery and delivery of a low-birthweight infant.

Assessment of iron-deficiency anemia compares individual hemoglobin and hematocrit levels to standard reference values. Table 15.17 lists the CDC criteria for determining anemia, based on age and gender. Adjustments to these values must be made for individuals who live at altitudes greater than 3,000 ft and for smokers. An adjustment of 10.3 g/dL is required for adolescents who smoke.[37] Because male adolescents are not at high risk for iron-deficiency anemia, they do not need to be screened unless they exhibit one or more of the risk criteria listed. All adolescent females should be screened every 5 years for anemia; those with one or more risk factors for anemia and those who are elite athletes should be screened annually. Treatment that follows a diagnosis of iron-deficiency anemia needs to include increased dietary intake of foods rich in iron and vitamin C as well as iron supplementation as recommended by a primary care provider.

Adolescents often report gastrointestinal side effects from iron supplementation, such as constipation, nausea, and cramping. These side effects can be lessened by giving smaller doses of iron more frequently throughout the day and counseling the adolescent to take the iron supplement at mealtimes or with food sources of vitamin C. Calcium supplements, dairy products, coffee, tea, and high-fiber foods may decrease absorption of iron supplements; these foods should be avoided within 1 hour of taking an iron supplement.

Table 15.17 Maximum hemoglobin concentration and hematocrit values for iron-deficiency anemia

Sex/Age[a]	Hemoglobin (<g/dl) Less Than:	Hematocrit (<%) Less Than:
Males and Females		
8–12 years	11.9	35.4
Males		
12–15 years	12.5	37.3
15–18 years	13.3	39.7
18+ years	13.5	39.9
Females[b]		
12–15 years	11.8	35.7
15–18 years	12.0	35.9
18+ years	12.0	35.7

[a]Age- and sex-specific cutoff values for anemia are based on the 5th percentile from the third National Health and Nutrition Examination Survey.

[b]Nonpregnant and lactating adolescents.

Source: Abridged from Centers for Disease Control and Prevention. Recommendations to prevent and control iron deficiency anemia in the United States. *Morb Mortal Wkly Rep.* 2002; 51(40):897–899.

Key Points

1. Nineteen percent of adolescents have obesity and 6 percent have severe obesity.
2. National guidelines specify a four-stage approach to weight management for adolescents, which may include bariatric surgery in the presence of extreme obesity or life-threatening comorbid conditions.
3. Teen athletes should consume 6–8 oz of fluid prior to exercise, 4–6 oz every 15–20 minutes during physical activity, and at least 8 oz of fluid following exercise to maintain proper hydration.
4. Dieting is common among adolescents of all BMI categories and can increase the risk of developing disordered eating or eating disorders.
5. Weight stigmatization may increase the risk of obesity and eating disorders; thus, a weight-inclusive approach to nutrition counseling is recommended for adolescents and their families.
6. Risk factors for iron deficiency anemia, the most common nutrition deficiency among adolescents, include rapid growth, low dietary iron intake, meal skipping, dieting, athletic participation, and heavy menstrual bleeding.
7. Cholesterol levels drop during puberty, thus routine screening for hyperlipidemia should be done before age 10 and again after age 17.
8. Eating disorder rates have increased during the pandemic.

Review Questions

1. Stage 2 treatment for adolescent obesity can be offered by a single provider.

   _____ True _____ False

2. At which state of obesity treatment is a structured eating plan designed to create a caloric deficit?

   a. Stage 1
   b. Stage 2
   c. Stage 3
   d. Stage 4

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3. Which of the following nutrients may be required in greater amounts by adolescents who use alcohol and tobacco?
   a. Thiamin
   b. Iron
   c. Vitamin C
   d. All of the above.
4. Which is not a criterion for inpatient treatment of eating disorders?
   a. Social isolation or depression
   b. Excessive parental expectations
   c. Weight loss of more than 10 lb in 3 months
   d. Unwillingness to eat or drink
5. All of the following criteria are required for adolescent bariatric surgery, except:
   a. Failure to lose weight during intensive lifestyle program
   b. BMI >40 with medical complications
   c. Family history of obesity-related deaths
   d. Supportive home environment
6. How does binge-eating disorder differ from bulimia nervosa?
7. How does the use of substances such as alcohol, tobacco, and recreational drugs affect the nutritional status of adolescents?

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Amanda Mills/CDC

Adult Nutrition

Prepared by Patricia L. Splett

Learning Objectives

After studying the materials in this chapter, you should be able to:

16.1 Discuss different types of nutrition-related risk factors and how they are monitored in adults.

16.2 Describe normal physiological changes in adulthood and how they are associated with the development and progression of chronic diseases.

16.3 Estimate your daily energy needs using three methods and discuss factors that affect energy needs of adults.

16.4 Identify nutrients that are consumed in excessive and inadequate levels and the consequences for adult health.

16.5 Explain the purpose of dietary guidance and how it translates science into healthful food and beverage choices and pleasurable eating experiences for adults.

16.6 Describe national recommendations for physical activity and the benefits of regular physical activity.

16.7 Contrast the multiple strategies used to promote and support good nutrition of adults.

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Introduction

"Healthy living is the best revenge."

—Earl S. Ford[1]

Adulthood marks a long period between the active growth and development phases of infancy, childhood, and adolescence and the older adult phases where a concern is sustaining physical and mental capacity. Adulthood is subdivided into the following segments.

Early Adulthood: The twenties generally involve becoming independent, leaving the parental home, finishing formal schooling, entering regular employment and starting a career, developing relationships, and choosing a partner. Planning, buying, and preparing food are newly developing skills for many. The thirties could be characterized by increasing responsibilities to and for others, including having children, providing for and caring for family, building a career, and involvement in community and civic affairs. There may be renewed interest in nutrition at this time "for the kids' sake."

Midlife: The forties are a period of active family responsibilities (that may include nurturing children and teenagers and, for some, building new relationships and blending families), as well as expanding work and professional roles. Managing schedules and meals becomes a challenge. Sociologists say that this is a time of reviewing life's accomplishments and beginning to recognize one's mortality.

The phase around the fifties is referred to as the **sandwich generation**. Many, especially women, are multigenerational caregivers who juggle the roles of caring for children and aging parents while maintaining a career. Work and career continue to be priorities for most adults. In the fifties, health concerns frequently are added to the picture. Dealing with a chronic disease or managing identified risk factors to prevent diseases is an added responsibility.

Later Adulthood: By their early sixties, many adults are making the transition to retirement, have more leisure time, and are able to give greater attention to physical activity and nutrition. While many are "empty-nesters," significant numbers have children living at home and/or have responsibilities as guardians and caretakers of grandchildren, parents, or others. Food choices and lifestyle factors may take on added significance for those who are dealing with a chronic disease.

sandwich generation Refers to middle-aged adults, usually women, who are multigenerational caregivers dealing with the complex roles of wife, mother, daughter, caregiver, and employee.

healthy weight A weight range compatible with normal function and long, healthy life.

This chapter explores the nutritional needs of adults and nutrition guidance and interventions aimed at helping meet those needs. During the adult years, the focus is on preserving health, maintaining a **healthy weight**, and minimizing risks for and delaying or preventing the onset of chronic diseases.

Importance of Nutrition

The span of years between ages 20 and 64 is a time when diet, physical activity, smoking, and body weight strongly influence the future course of health and wellness. During these 44 years, lifestyle choices interact with genetic endowment, social forces, and environmental factors to determine years of life and quality of life.[2] Today, about half of all American adults are living with one or more preventable chronic diseases. Complicating this is the fact that over two-thirds of American adults are living with overweight or obesity, a factor in all of the major chronic diseases.[3]

The onset and severity of heart disease, stroke, diabetes, some cancers, and liver disease (5 of the 10 leading causes of death in adults) have risk factors that can be modified through changes in nutrition and physical activity. Problematic dietary practices that are common in American diets are identified in Table 16.1 as carcinogenic, atherogenic, and obesogenic. Changes in these practices, at the individual and population level, could reduce the impact of these chronic diseases during the adult years.

16.1 Tracking Adult Nutritional Health and Its Determinants

Nutrition status and factors that promote or interfere with achieving optimum nutrition status of the adult population are tracked using standard indicators. Data at the local, state, and national level are used to identify problem areas, shape interventions, and measure progress. The monitoring process starts with assessing food intake, nutrient adequacy, and weight status, along with behavioral and environmental risk factors at the individual level. Then data are summarized across population groups and reported.[4,5] Some key indicators for the United States are shown in Table 16.2. Using the website below the table, go to Prevalence and Trends Data and fill in the values for your state, race/ethnic group, age group, and income group.

What adults eat is not strictly a matter of individual choice; what they eat and the resulting nutrition status are shaped by many external factors. Where people learn, work, worship,

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Table 16.1 Modifiable nutritional risk factors for chronic diseases*

Cancer	**Carcinogenic diet** • Low fruit and vegetable intake • Low level of antioxidants (especially vitamins A and C) • Low intake of whole grains and fiber • High dietary fat intake • Nitrosamines, burnt and charred food • High intakes of pickled and fermented food • Alcohol consumption • High animal-food, low plant-food intake
Heart Disease	**Atherogenic diet** • High saturated fat (>10% calories) • *Trans*-fatty acid intake • Dietary cholesterol intake >300 mg • Low fruit and vegetable intake • Low antioxidants • Low intake of whole grains • Excess alcohol intake • High sodium intake • Low potassium intake • Low intake of milk and dairy foods • High waist circumference (men > 40 in., women > 35 in.)
Obesity	**Obesogenic diet** • Caloric intake exceeding needs • Unstructured eating • Frequent fast-food consumption • High fat intake • Sugar-sweetened beverage consumption • Energy-dense, nutrient-poor food choices
Diabetes	Atherogenic diet Obesogenic diet

*Obesity (BMI > .30) and physical inactivity are also independent risk factors for all of the chronic conditions.

Table 16.2 Chronic disease indicators: Physical activity and nutrition

Indicator	U.S. Prevalence Rate	Your State*	Race/ Ethnic Group	Age Group	Income Group
Consume fruit (one or more times per day)	60.2% (2019)				
Consume vegetables (one or more times per day)	79.6% (2019)				
Obesity (BMI ≥30)	31.9% (2020)				
Overweight (BMI 25–29.9)	35.2% (2020)				
150 minutes or more aerobic physical activity per week	49.9% (2019)				

*Check the chronic disease indicators for your state and for your race/ethnic, age, and income groups. Go to CDC, Behavioral Risk Factor Surveillance System, Prevalence & Trend Data at www.cdc.gov/brfss/data_tools.htm.

and play; the community they live in; as well as policies and politics, all affect their ability to access a variety of affordable, healthful food and live a healthful lifestyle. The complexity of external factors is depicted in Figure 16.1. Key environmental factors that are largely outside of the control of the individual, but have great impacts on access to resources needed for health, are called the **social determinants of health**.[6] A person's continuous exposure to disadvantage and inequities in their local community, compounded with discrimination, produces stress, and raises challenges that reduce access to health promoting opportunities and results in health disparities (discussed later).

Understanding the external factors that contribute to individual and population health is important for identifying the problem, planning interventions, and monitoring progress.[6] The social determinants of health model goes beyond the biological and genetic makeup and behaviors at the individual level. It organizes the complex and interacting factors that determine health and nutritional well-being of the population and provides a framework so these factors can be monitored and addressed at the population as well as the clinic level (Figure 16.2).[7,8]

Health Objectives for the Nation

Healthy People 2030 objectives address multiple health improvement goals for adults.[9] The nutrition goal focuses

carcinogenic diet A pattern of eating and food choices that increases the risk of some cancers.

atherogenic diet A pattern of eating and food choices that promotes deposits of plaque in arterial walls and contributes to the development of cardiovascular disease.

obesogenic diet A pattern of eating and food choices that leads to excessive energy intake and accumulation of body fat.

social determinants of health Socioeconomic and environmental factors that are powerful determinants of health and are largely outside of the control of individuals and groups, but affect a wide range of health, functioning, and quality of life outcomes.

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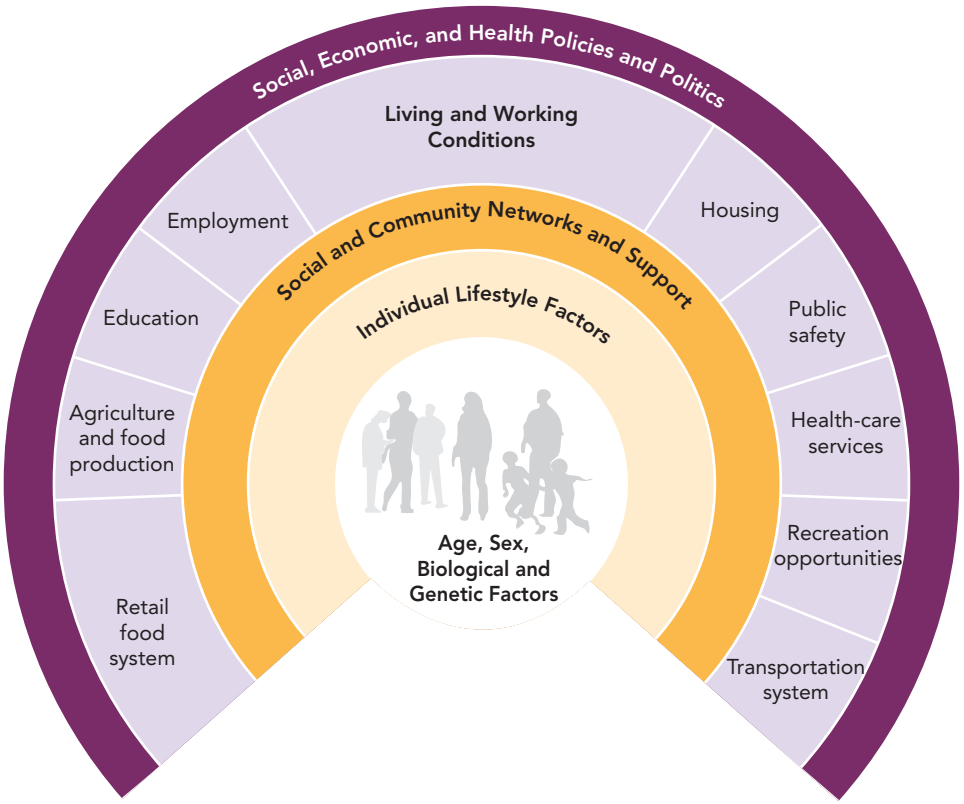


Figure 16.1 External factors interacting with individual factors to affect nutrition and health.

on improving health by promoting healthy eating and making nutritious foods available. Selected nutrition objectives, listed on Table 16.3, illustrate what is being emphasized and tracked in the United States. Baseline values used for 2030 objectives as well as those for 2020 objectives are shown so you can see the amount of progress made over the past decade, along with the target for the current decade.

Health Disparities Among Groups of Adults

Some population groups have earlier onset, a higher rate, and worse outcomes of chronic diseases than others. This

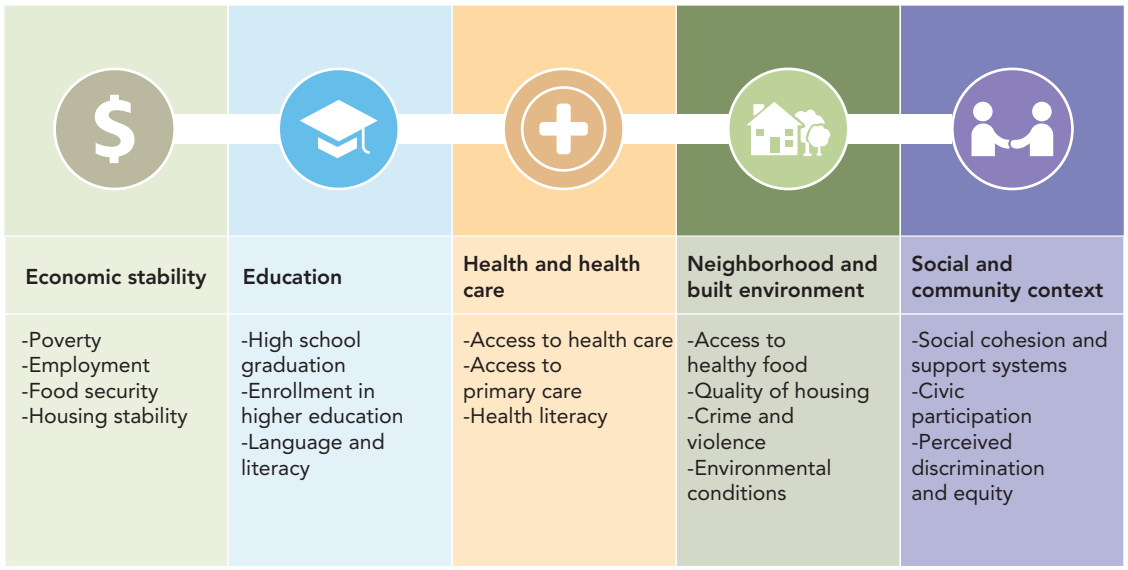


Figure 16.2 Healthy People 2030 social determinants of health.

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Table 16.3 Healthy People 2030 objectives: Nutrition and health promotion

Objective	2020 Baseline	2030 Baseline	Target for Improvement
Weight			
Reduce the proportion of adults with obesity	34.0%	38.6%	36%
Food and Nutrient Consumption (for population aged 2 years and older)			
Increase contribution to the diet			
Fruit (cup equivalent/1,000 calories)	0.5 cup	0.51 cup	0.56 cup
Total vegetables (cup equivalent/1,000 calories)	0.8 cup	0.76 cup	0.84 cup
Dark green, red, and orange vegetables, and bean and peas (cup equivalent/1,000 calories)	0.1 cup	0.31 cup	0.33 cup
Whole grains (ounce equivalent/1,000 calories)	0.3 oz	0.46 oz	0.62 oz
Calcium (milligrams/day)	1,118 mg	1,077 mg	1,184 mg
Reduce percent of total calories consumed from			
Added sugars (percent of calories)	15.7%	13.5%	11.5%
Saturated fats (percent of calories)	13.3%	11.4%	8.4%
Sodium (milligrams/day)	3,641 mg	3,406 mg	2,725 mg
Community Actions			
Reduce household food insecurity and hunger	12.3%	11.1%	6%
Increase the proportion of worksites that offer a nutrition program as part of an employee health promotion program	Developmental*		
Increase the number of community-based organizations providing population-based primary prevention services	Developmental*		
Primary Health-Care Settings			
Increase the proportion of health-care visits by adults with obesity that include counseling on weight loss, nutrition, or physical activity	28.9%	24.8%	32.6%

*Baselines and targets have not been set for developmental objectives.

Source: U.S. Department of Health and Human Services. Office of Disease Prevention and Health Promotion. Healthy People 2030. Washington, DC. Available at healthypeople.gov/2030.

health disparity is illustrated by comparisons of disease prevalence in men and women adults of different racial/ethnic backgrounds and income levels:[10]

- Obesity patterns vary by race/ethnicity and income.
- An inverse association exists between family income and obesity prevalence among White women of all ages.
- While new cases of cancer have been going down for most groups, the number of new cases has increased for Native American women.
- Hispanic and Asian adult men have the highest rates of both diagnosed and undiagnosed diabetes, while White males have the highest rate of prediabetes.

Some groups have a genetic predisposition for certain diseases. Native Americans have a very high rate of diabetes; Asian Americans develop cardiovascular disease at a lower BMI and smaller waist circumference; and African Americans tend to have greater salt sensitivity and earlier onset of hypertension.[11] However, genetics, environment, and lifestyle behaviors interact to determine the actual development of the disease. What is of great concern is health inequity, defined as differences that are avoidable, unnecessary and unjust. Groups experiencing **health inequity** not only have higher prevalence of certain conditions and experience worse health compared to the general population, but also tend to have less access to environmental conditions that support health, such as healthy food, good housing, quality education, and safe neighborhoods (i.e., the social determinants of health). The impact of racism and other forms of discrimination is also recognized as a significant contributor to health disparity and inequity.[12] Eliminating disparity

health disparity Significant differences in the incidence, prevalence, mortality, and burden of disease and other adverse conditions that exist among specific population groups. Health disparity is closely linked to social and economic disadvantage.

health inequity Significant differences in the incidence, prevalence, mortality, and burden of disease and other adverse conditions that exist among specific population groups that are avoidable, unnecessary and unjust.

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and advancing health equity is a priority within Healthy People Goals for 2030, and objectives under many topic areas, including nutrition, aim to create social and physical environments that promote good health for all.

Food access and associated diet-related health disparity is an important aspect of this issue. Health and nutrition data are commonly analyzed and reported by age, sex, racial/ethnic, and income subgroups, allowing for disparities to be identified. However, adults in many other categories, such as the LGBTQ+ community, cultural and religious minorities, immigrants, migrants, and people with physical and mental impairment, experience discrimination and exclusion, and have disadvantages leading to health inequities. Studies that look deeper, commonly identify significant disparities in access to food and healthcare services among these groups.

Social and environmental risk factors can be gradually changed; however, to speed progress, more data about the determinants of health are being monitored and policy and environmental change strategies are receiving greater emphasis.[6-12] At the local level, community groups and organizations are engaged in efforts to assess and identify needs, with special attention to needs of marginalized groups, and then undertake initiatives to change detrimental environmental conditions and address inequities within their communities.[13]

16.2 Physiological Changes During the Adult Years

For the most part, individuals have stopped growing by the time they reach their twenties. Men and women continue to develop bone density until roughly age 30. Peak bone mass is related to the amount of dietary calcium and weight-bearing exercise in prior years. Muscular strength peaks around 25–30 years of age and later dexterity and flexibility begin to decline, although regular use of muscles and weight training affects strength as well as muscle size and retention. The type and amount of physical activity have a significant impact on body composition, including **lean body mass**, fat accumulation and relocation, and bone density.[14] Sensory and perceptual abilities change. Hearing loss begins as early as age 25 (or earlier with exposure to loud noises and music), and vision changes often become noticeable by age 40. Blood flow to muscle, skin, and all tissues of the body are impacted by gradual changes in cardiovascular function include decrease in maximal heart rate and increase in rigidity (stiffness) of blood vessels.[15] Other body composition changes slowly occur in tandem with hormonal shifts.

lean body mass Sum of fat-free body tissue: muscle, mineral (as in bone), and water.

climacteric change Point in life where crucial changes occur; refers to the loss of reproductive activity, marked by menopause in women and reduction in testosterone production in men.

perimenopause and menopause An approximately 4-year period of decreasing estrogen production followed by the end of menstruation; a marking point for increased risk of cardiovascular disease and other chronic conditions for women.

energy balance An equilibrium state in which the number of calories consumed equals the number of calories expended.

Hormonal and Climacteric Changes

Changes associated with the end of reproduction are referred to as **climacteric changes**. The decline of estrogen production, which begins in women during their early fifties, begins **perimenopause** and continues through **menopause,** the end of reproductive capacity. Women with greater body mass tend to have a later menopause. Menopause is associated with an increase in abdominal fat and significant increase in risk of cardio-metabolic risk and accelerated loss of bone mass.[16] In addition to effects on the female reproductive system, estrogen, in both men and women, is involved in the supply of calcium to bones, health of blood vessel walls, blood cholesterol and triglyceride levels, and elasticity of the skin. Obesity is associated with higher estrogen levels in men and women due to the production of estrogen by fat cells. After age 30, men experience a gradual decline in testosterone level and muscle mass. Physical activity and weight training to increase muscle mass also result in small and transient increases in testosterone level.

Transgender people undergoing gender-affirming treatment, which involves cross-sex hormone therapy, may experience weight gain, changes in body composition, altered lipid profiles, and changes in bone composition. These changes are affected by the age at which hormonal transition occurs.[17]

Body Composition Changes in Adults

Bone Bone shape is modified in response to physiological influences and mechanical forces. The ongoing process of bone remodeling preserves bone strength and mineral (calcium and phosphorus) homeostasis. Around age 40, men and women begin to gradually lose bone mass. The risk of developing osteopenia (low bone mineral density) and osteoporosis (weak, porous bones with high risk for fracture) depends on the peak bone mass achieved in the late twenties.[18]

Adiposity Positive **energy balance** typical between ages 20 and 64 results in weight gain and storage of excess energy in adipose tissues. Storage begins with hypertrophy of subcutaneous fat cells, then shifts to deposits in the central and intra-abdominal space (visceral fat) and other tissues such as heart, blood vessels, liver, and muscle (ectopic fat). Obesity and visceral fat are strongly related to development of inflammation and metabolic disturbances, which are connected to insulin resistance, diabetes, gallbladder disease, hypertension, stroke, and coronary artery disease. Furthermore, risks for these diseases increase as weight and adiposity increase.[19]

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Immunosenescence There are changes in immune function during the adult years. **Immunosenescence,** or immune dysregulation, a progressive decline in immune function often evidenced by low-grade chronic inflammation, is not primarily the result of aging, but rather is produced by a person's environmental exposures and stresses and lifestyle factors, including nutrition and physical activity, over the life span.[20] Studies during the COVID-19 pandemic, where obesity was highly associated with more serious disease and death, have led to greater understanding of the links between obesity and immune function.

What is the relationship? Adipose tissue is a complex organ that comprises a wide range of cell types with diverse energy storage, metabolic regulation, and neuroendocrine and immune functions. Metabolism within fat cells undergoes change in response to its microenvironment, which can switch or reprogram **adipose tissue macrophages (ATM)** to produce pro-inflammatory versus anti-inflammatory **cytokins**.[21] Leanness, especially less abdominal fat, favors production of anti-inflammatory cytokines. In contrast, ATMs of obese individuals produce more pro-inflammatory cytokines, resulting in chronic low-grade inflammation and the diseases noted in the above adiposity paragraph, or in the case of COVID-19, an acute inflammatory response to infection. Moderate body weight, physical activity, adequate nutritional intake, and positive exposure to the social determinants of health all contribute to sustained immune function, and may attenuate age-related decline.[21]

Gut Microbiome The constellation of bacteria and other microbes that inhabit the gut is determined early in life. This complex microbial community shifts and adapts with age, diet, geographic location, stress, supplements, and medications; but each individual has a gut microbiota "fingerprint" that is relatively stable. The composition of gut microbiota determines the balance between beneficial and harmful actions in the gut lumen. Healthy gut microbiota functions to activate and support the immune system, protect against opportunistic pathogens, digest food to release nutrients and energy from diet, ferment nondigestible carbohydrates, synthesize vitamins (K, B_{12}, biotin, carnitine), stimulate renewal of cells of intestinal lining, control colonic motility and transit time, and provide regulatory signals through the gut–brain axis.[22] A breakdown in the balance between protective and harmful intestinal bacteria, **gut dysbiosis**, produces an inflammatory state that may present with acute symptoms, or result in insidious changes in body weight, insulin sensitivity, glucose metabolism, dyslipidemia, and other cardio-metabolic and carcinogenetic factors. Additionally, recent studies propose that dysbiosis contributes to the pathology of multiple neurological conditions and diseases, including cognitive impairment, neurodegeneration, and depression.[23] Interventions (including probiotics, prebiotics, and fecal transplant) can improve or prevent some pathological conditions.[23]

Continuum of Nutritional Health

With good genes, good habits, good environment, and good luck, the effects of aging can be minimized and nutritional and physical health can be maintained throughout adulthood. More likely, the interaction of those factors over the years results in "nutritional injury," which leads to alteration or loss of function at the cellular level. Nutritional injury may be minor, of short duration, and reversible, or, if it continues, permanent changes in cells and tissues can develop.[24] Several principles of human nutrition, presented in Chapter 1, bear repeating here to emphasize their relevance to nutritional health during the adult years:

- Health problems related to nutrition originate within cells.
- Poor nutrition can result from both inadequate and excessive levels of nutrient intake.
- Humans have adaptive mechanisms for managing fluctuation in food intake.
- Malnutrition can result from poor diets and from disease states, genetic factors, or combinations of these causes.
- Poor nutrition can influence the development of certain chronic diseases.
- Adequacy, variety, and balance are key characteristics of healthy diets.

Nutritional health can be viewed as a continuum (Figure 16.3), ranging from "healthy" and resilient to the terminal state in which the body systems shut down and life ceases. According to the **Continuum of Nutritional Health**, adapted from nutritional-injury models put forth by Arroyave and Leyse-Wallace,[24,25] changes occurring at the cellular level are initially insidious and unnoticed. Alterations progress over a long period and are reversible up to a point. But in the face of continued poor nutrition, permanent damage occurs. Altered nutrient intakes produce early changes in

immunosenescence A progressive decline in immune function, often evidenced by low-grade chronic inflammation.

adipose tissue macrophages (ATM) A type of cell within adipose tissue that switches in response to its microenvironment to be anti-inflammatory or pro-inflammatory.

cytokines Small secreted chemical messenger proteins that function as immunomodulating agents. Some cytokines stimulate the immune system and others slow it down.

gut dysbiosis Breakdown in the balance of protective and harmful bacteria and other microbes in the intestines.

Continuum of Nutritional Health Stages of nutritional status that range from optimal to unable to sustain life. The stages are resilient and healthy, altered substrate availability, nonspecific signs and symptoms, clinical conditions, chronic conditions, and terminal illness and death.

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Nutritional state	Resilient and healthy	Altered substrate availability	Nonspecific signs and symptoms	Clinical condition	Chronic condition	Terminal illness and death
Metabolic, physiological, functional status	Metabolic homeostasis Able to defend against injury	Reduction of nutrient stores or accumulation of excess Subclinical changes	Metabolic and physiologic alterations are observable	Evident illness and medical diagnosis	Altered metabolism and structural changes in tissues become permanent	Complications advance, body systems shut down
Focus of nutrition guidance, education, or therapy	Dietary guidance to support adequate intake and anticipate risks	Dietary guidance and education to inform about risks and encourage healthy eating and lifestyle choices	Nutrition education and counseling to reduce or reverse specific risk factors	Intensive medical nutrition therapy or therapeutic lifestyle change programs to delay progression	Medical nutrition therapy and patient education to enable self-management of the condition and prevent complications	Comfort care
	← Continuum of nutritional health and intervention →					

Figure 16.3 Continuum of nutritional health.

metabolic process that are preclinical stages of illness. This "injury" may not manifest itself until permanent damage has occurred. In the absence of signs and symptoms and awareness of a "problem," adults might not be especially concerned about food choices or motivated to adjust lifestyle behaviors.

States of Nutritional Health

The continuum of nutritional health can be represented in six states or stages.

1. **Resilient and "Healthy"** In this state, metabolic systems are in homeostasis, and organs are functioning at optimum level. The body's defenses and immune system can counter assaults from toxins, pathogens, and stress. In this stage, nutritional guidance and education are used to encourage adequate intake—not too much, not too little—of a variety of healthful foods. The mantra is "moderation, variety, and balance." Anticipatory guidance is used to enable healthy individuals to anticipate and plan for possible risks so they are able to make informed choices that sustain resilience and prevent nutritional injury.
2. **Altered Substrate Availability** This early, subclinical state of nutritional harm occurs when intake does not meet needs. There is a loss of reserves and/or accumulation of excesses. Nutrients are drawn out of other body compartments, such as protein out of muscle or lung tissue and calcium from bones. There may be a buildup of by-products resulting from inefficient or altered metabolism. When substrates are not available in appropriate amounts, adaptive mechanisms kick in, but they reach limits. If measured, blood and other biochemical markers could show subclinical changes, but without physical signs or risk indicators, such laboratory testing normally is not done. Nutrition education and **dietary guidance** directed at the public at large attempts to inform people about common risks and encourages healthful diets and lifestyle choices to minimize or reverse subclinical changes.
3. **Nonspecific Signs and Symptoms** Eventually, insufficient or excessive intake of nutrients or energy leads to observable changes. Examples include the accumulation of subcutaneous fat and central adiposity, elevated blood pressure, and insulin resistance. These changes are well-recognized risk factors for the development of chronic diseases. By this stage, immune function is affected and there is reduced resistance to pathogens, chemical exposures, radiation, and stress, including the continued stress of nutrient imbalance. Screening should identify these changes and signal the need for intervention. Dietary guidance, nutrition counseling, and medical nutrition therapy, delivered individually or in groups, are potential interventions to assist individuals in making changes at this stage. Goals of intervention target specific risk factors and observable signs and

dietary guidance Providing concise recommendations and consumer information to guide food choices.

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symptoms. These can be measured and monitored over time to assess progress in halting or reversing nutritional injury and risk factors for disease.

4. **Clinical Condition** Genetic predisposition, interacting with dietary components and other environmental factors, influences whether and when the clinical condition develops. If changes aren't made and the nutritional injury persists, frank signs and symptoms of illness are now present and a medical diagnosis such as atherosclerosis, oste oporosis, cancer, type 2 diabetes, or depression is made. A clear medical diagnosis is the turning point for serious lifestyle change for some adults. Change is difficult, and intensive intervention such as medical nutrition therapy or therapeutic behavior change programs (discussed in Chapter 17) may be necessary to manage the disease and prevent or delay its progression and the development of side effects and complications.
5. **Chronic Condition** At this stage, altered metabolism and structural changes in tissues become permanent and irreversible. Examples are structural damage to coronary arteries, invasive and metastatic cancer, loss of kidney function, or blindness. Major adjustments of life are necessary to manage the chronic disease and accommodate conditions that have significant impact on quality of life. Intervention at this stage is aimed at managing the condition, preventing further complications, reducing the degree of disability, and optimizing quality of life.
6. **Terminal Illness and Death** At the final stage in the continuum, complications advance, body systems shut down, and life ceases.

16.3 Energy Recommendations

Energy requirements are defined as the amount of dietary energy intake needed to be consumed by individuals to sustain stable body weight consistent with long-term good health that would allow for adequate levels of physical activity to maintain social, cultural, and economic activity.[26] A healthy weight for most individuals is indicated by a BMI of 18.5 up to 25 kg/m^2.

Age-Related Changes in Energy Expenditure

Metabolic rate and energy expenditure begin to decline in early adulthood at a rate of about 2.9 percent for men and 2.0 percent for women per decade.[27] These reductions generally correspond to declines in physical activity and lean muscle mass. Between ages 25 and 65, physical working capacity (measured by VO_2 max) declines by 5–10 percent per decade. The presence of musculoskeletal disease, obesity, and other conditions can accelerate declines in energy expenditure and physical capacity.

In young, healthy adults, there is compensatory adjustment between physical activity and calorie intake. Studies indicate this is also true for older adults.[28] In the mid-1960s, researchers at the Baltimore Longitudinal Study on Aging (BLSA) reported that caloric intake in men decreased 22 percent, from 2,700 to 2,100 calories, between age 30 and age 80.[29] They suggested that the decrease was due to lowered metabolic rates as well as decreased activity levels. However, the current trend of higher body weight and the increasing rate of overweight and obesity through the adult decades indicates that behavioral, social, and environmental factors supersede the innate physiological ability to adjust caloric intake with energy expenditure.[30]

Estimating Energy Needs in Adults

Energy needs are based on an individual's **basal metabolic rate (BMR)**, the **thermic effect of food (TEF)**, and **activity thermogenesis**. The largest component of daily energy expenditure, 60–75 percent for most adults, is the involuntary process of internal chemical activities that maintain the body.[31] While the brain, liver, gastrointestinal tract, heart, and kidney make up less than 5 percent of body weight, the active metabolic processes and functions of these organs account for about 60 percent of BMR. Additional energy is required for the digestion, absorption, and metabolism of food—referred to as the thermic effect of food (TEF). This amounts to approximately 10 percent of energy needs but varies with diet composition and across individuals. TEF is lower in some individuals with obesity, suggesting that more efficient digestion and absorption of food may be a factor in obesity.[32] The most variable component of energy expenditure is activity thermogenesis (which includes energy expended through exercise and nonexercise activity such as fidgeting), accounting for 20–40 percent of total energy expenditure.

Energy needs of an individual can be estimated in several ways. The Food and Nutrition Board determined **estimated energy requirements (EERs)** from studies that measured total daily energy expenditure by the doubly labeled water (DLW) technique.[26] The DLW technique is a very precise method of measuring energy utilization in

basal metabolic rate (BMR) Amount of energy required for cellular metabolic processes and function of organs. It is measured in an individual who has been awake less than 30 minutes and is still at absolute rest, has fasted for 10 hours or more, and is in a quiet room with normal, comfortable temperature.

thermic effect of food (TEF) Energy required for the digestion, absorption, and metabolism of food; approximately 10 percent of energy needs.

activity thermogenesis Energy expended through physical activity and nonexercise activity such as fidgeting.

estimated energy requirement (EER) The average dietary energy intake for adults in good health, by age, gender, weight, height, and level of physical activity, that is predicted to maintain energy balance and is consistent with good health.

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Table 16.4 Estimated Energy Requirements (EER) equations based by age, sex, and physical activity in adults 19 years and above with sample calculation

Age Group	Sex	PAL Category	EER Equation (kcal/day)
19+ years	M	Inactive	EER = 753.07 − (10.83 × age) + (6.50 × height) + (14.10 × weight)
		Low active	EER = 581.47 − (10.83 × age) + (8.30 × height) + (14.94 × weight)
		Active	EER = 1,004.82 − (10.83 × age) + (6.52 × height) + (15.91 × weight)
		Very active	EER = -517.88 − (10.83 × age) + (15.61 × height) + (19.11 × weight)
	F	Inactive	EER = 584.90 − (7.01 × age) + (5.72 × height) + (11.71 × weight)
		Low active	EER = 575.77 − (7.01 × age) + (6.60 × height) + (12.14 × weight)
		Active	EER = 710.25 − (7.01 × age) + (6.54 × height) + (12.34 × weight)
		Very active	EER = 511.83 − (7.01 × age) + (9.07 × height) + (12.56 × weight)

NOTES: kcal/d = kilocalories per day; PAL = physical activity level; EER = Estimated Energy Requirement; TEE = total energy expenditure. For weight stable adults, EER (kcal/d) = TEE (kcal/d). Age is in years, weight is in kilograms, and height is in centimeters.

Source: National Academies of Sciences, Engineering, and Medicine. *Dietary Reference Intakes for Energy*. Washington, DC: The National Academies Press, 2023. doi: https://doi.org/10.17226/26818.

real living conditions (i.e., not the laboratory). Subjects are given a dose of "tagged" water containing "heavy" isotopes of hydrogen and oxygen. Excretion of isotopes in saliva and urine is used to calculate average energy utilization over several days. Table 16.4 shows the 2023 DRI energy EER equations for adults based on age, sex, and physical activity levels. For the EER in Table 16.5, the reference man is 5 ft 10 in. tall and weighs 154 lb, and the reference woman is 5 ft 4 in. tall and weighs 126 lb. For each 2 in. of extra height, add 90 cal if a woman and 125 if a man. For individuals experiencing overweight and obesity (BMI 25–40 kg/m^2), energy requirements are higher (by 120–400 cal per day) due to the increased energy cost of carrying extra weight.

Indirect calorimetry is used to determine **resting energy expenditure (REE),** a measure closely related to basal metabolic rate. Indirect calorimetry is done by measuring the exchange of gases during respiration (oxygen consumption and carbon dioxide production), for a specific period of time, using a metabolic cart in hospitals or portable technology and handheld devices in clinics and gyms. The respiratory quotient (VCO_2/VO_2) is used to estimate 24-hour energy expenditure.

resting energy expenditure (REE) Measured or estimated energy expenditure in an individual at rest.

REE can also be calculated using a validated estimation formula. The Mifflin–St. Jeor formula was developed for healthy, normal-weight, and moderately overweight men and women. It requires accurate measures of height (cm) and weight (kg).[33]

Mifflin–St. Jeor Energy Estimation Formula

Males: REE = (10 × wt) + (6.25 × ht) − (5 × age) + 5

Females: REE = (10 × wt) + (6.25 × ht) − (5 × age) − 161

After the REE has been determined, the value is multiplied by an activity factor (1.2 sedentary, 1.55 moderately active, or 1.725 very active) to arrive at the estimated daily calorie expenditure.[27]

Body composition, primarily fat-free mass, plays a significant role in REE. Estimation formulas have been found to underestimate REE of lean, fit adults and overestimate the REE of overweight and obese adults. Larger individuals with more muscle tissue have higher energy requirements.[31,33] Numerous energy calculators based on height and weight are available online. For more athletic individuals, a formula based on lean body mass is recommended, which produces a higher and more accurate EER reflecting the effect of greater lean muscle mass on BMR.[32] Another calculator, used in the MyPlate Tracker, adds the energy cost of physical activity by incorporating physical activity level in estimates.[34] A simple calculation can also be used to "ballpark" caloric levels for weight maintenance, weight

Table 16.5 Estimated caloric needs per day by age, sex, and physical activity level

Sex	Age	Inactive	Low Active	Active	Very Active
Female	19-31	1,975-2,050	2,100-2,200	2,250-2,350	2,500-2,600
	31-50	1,800-1,975	2,000-2,100	2,100-2,250	2,350-2,500
	51-65	1,700-1,800	1,900-2,000	2,000-2,100	2,250-2,350
Male	19-31	2,575-2,700	2,775-2,900	2,950-2,075	3,275-2,400
	31-50	2,350-2,575	2,550-2,775	2,700-2,950	3,050-3,275
	51-65	2,200-2,350	2,400-2,550	2,575-2,700	2,900-3,050

Source: National Academies of Sciences, Engineering, and Medicine. *Dietary Reference Intakes for Energy*. Washington, DC: The National Academies Press, 2023. doi: https://doi.org/10.17226/26818.

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loss, or weight gain. Approximately 15 cal per lb of body weight per day are needed to maintain weight. Cutting to 13 cal per lb per day can result in weight loss and increasing to 17 cal per lb per day can produce weight gain.[35]

Energy Adjustments for Weight Change

A pound of body weight is the equivalent of approximately 3,500 cal. To lose 1 lb a week, an adult would need to create a negative calorie balance of 500 calories daily. These 500 cal can be generated from a combination of decreased calorie intake and increased physical activity. For instance, briskly walking two extra miles uses roughly 200 cal, and eliminating 12 oz of regular cola and a single-serving bag of potato chips (1 oz) allows subtraction of 300 cal, summed to total 500 cal. Seven days of burning 200 extra calories through physical activity and eating 300 fewer calories leads to a weight loss of approximately 1 lb. On the other hand, a positive balance of just 100 extra calories per day will result in a gain of 10 lb in a year!

Tracking Energy Expenditure

Wearable technology, such as wrist bands developed for sports and medical applications and smartphones and smartwatches can now monitor real-time energy expenditure and other physiological indicators with variable accuracy.[36] Body movement sensors measure distance (steps), vertical acceleration (flights of stairs), and sitting/sedentary time, and physiologic sensors measure heart rate and some even measure skin temperature and sweat (lactic acid, oxygen, VO_2 max, indicators of exercise intensity). Algorithms within the device use data from sensors to determine activity type, intensity, and duration. Starting with EER for age, sex, height, and weight, activity energy utilization is added and calories burned shows on the screen. Devices with advanced technology "learn" from the user's data to provide more refined estimates. Integrated technology can link metrics from wearable devices to exercise, fitness, and weight-loss apps that track progress and provide motivational messages. Some applications allow data to be connected to medical and research programs. Studies indicate that feedback from wearable technology and associated apps help adults reach calorie, activity, and weight-loss goals.[37]

Energy Balance

Adults need to pay attention to the delicate balance between energy in and energy out. A myriad of lifestyle, social, and environmental factors make consumption of extra calories easy and burning those calories up thorough physical activity more difficult. Studies have linked the obesity epidemic to small, reoccurring excesses in energy intake over energy enpenditure.[38]

Reduction of total energy intake enhances weight loss regardless of the macro composition of the diet.[39] It doesn't matter if the diet is low fat, high protein, low carb, or a balanced combination (as long as micronutrient needs are met); the point is to consume fewer calories and to incorporate more physical activity.

16.4 Nutrient Recommendations

"Poison is in everything, and no thing is without poison. The dosage makes it either a poison or a remedy."

—Paracelsus, Swiss alchemist, 1493–1541

Macro- and Micronutrient Recommendations

The Institute of Medicine's recommendations for macronutrient (carbohydrate, fat, and protein) intake are expressed in ranges of percentage of total calorie intake. The wide ranges account for the fact that various eating patterns can be healthful.[26]

Acceptable Macronutrient Distribution Ranges (AMDR) for adults are:

- Fat 20–35 percent of calories
- Carbohydrate 45–65 percent of calories
- Protein 10–35 percent of calories

For comparison, the 2011–2014 NHANES found that the average macronutrient range for adults was about one-third fat and one-half carbohydrate.

Table 16.6 lists recommended nutrient intakes for adults using the DRIs or the Daily Values (DV) used in food labeling and shows average intakes based on NHANES survey data.[40,41] Risk nutrients include excessive intake of fats, sugar and sodium, and low intakes of fiber and several vitamins and minerals. Physiological and metabolic mechanisms can be compromised with excessive, inadequate, or imbalanced intake of these risk nutrients.

Risk Nutrients

Fiber Dietary fiber decreases the energy density of the diet and a high-fiber diet is linked with lower body weight and less weight gain overtime. Fiber slows gastric emptying time and produces a longer sensation of fullness. Fiber has many benefits beyond its effect on bowel mobility. The action of dietary fiber depends on its form. **Viscous fiber** such as that in oatmeal decreases the absorption of cholesterol, increases fecal excretion of cholesterol-rich bile, and results in lower blood levels of total and LDL cholesterol. **Fermentable fiber**, such as the skin of fruit and wheat or corn bran, enters the colon undigested and is fermented by gut bacteria. Higher intake of fermentable fiber promotes the development of a beneficial mix of microbiota in the gut, which stimulates the immune

viscous fiber Types of fiber characterized by their ability to form a gel solution when combined with liquid. Formerly called soluble fiber.

fermentable fiber Type of fiber that enters the large colon undigested, where it is acted on by the bacteria of the gut. Formerly called insoluble fiber.

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Table 16.6 Selected nutrient intakes of adults, NHANES 2017–2018, compared to recommendations

Nutrient	Intake				
	Actual				Recommended[a]
	20–29 Years		40–49 Years		31–50 Years
	Males	Females	Males	Females	Males/Females
Energy, kcal	2,409	1,985	2,605	1,921	–
Protein, g	93	74	105	69	56/46
Total fat, g	96	82	107	79	65 (DV)[b]
Saturated fat, g	31	28	34	26	20 (DV)[b]
Alpha-linolenic acid (omega 3), g	2.0	1.8	2.2	1.8	1.6/1.1
Cholesterol, mg	346	281	371	267	≤300 (DV)[b]
Total carbohydrate, g	271	230	293	226	300 (DV)[b]
Fiber, g	17	16	19	15	38/25
Total sugar, g	105	99	128	106	50 (DV)[b]
Sodium, mg	4,219	3,326	4,247	2,984	<2,400
Vitamin A, mcg RAE	604	604	746	642	900/700
Vitamin B_{12}, mcg	5.6	3.8	6.6	3.8	2.4
Folate, mcg DFE	618	474	587	466	400
Vitamin C, mg	69	74	86	83	90/70
Vitamin D mcg	4.8	3.8	4.3	3.8	20[c]
Vitamin E, mg TE	9.5	9.0	11.7	8.4	15
Vitamin K, mcg	96	121	147	140	120/90
Choline, mg	366	292	400	280	550/425
Calcium, mg	1,136	933	1,129	863	1300
Iron, mg	15.8	12.6	16.8	12.6	8/18
Magnesium, mg	323	268	359	270	420/320
Potassium, mg	2,643	2,309	3,053	2,288	4,700
Zinc, mg	12.7	9.8	14.0	9.2	11/8
Caffeine, mg	111	113	209	197	Up to 250[d]
Alcohol, g[e]	13.7	6.6	13.7	6.6	20/8[f]

[a]Recommended intake according to DRI 2005 or to DV nutrient reference amount used on food labels, relevant to a 2000 kcal diet.

[b]Based on a 2,000-kcal diet; for other caloric levels, the 2020–2025 Dietary Guidelines recommendation is up to 35% of calories from fat and 10% from saturated fat.

[c]Assumes inadequate exposure to sunlight.

[d]Considered a safe level by the FDA.

[e]Alcohol intake is reported for ages 20 and over because of wide variability within groups.

[f]Based on Dietary Guidelines for Americans.

Source: *What We Eat in America*, NHANES 2017–2018. Nutrient Intakes from Food and Beverages. U.S. Department of Agriculture, Agriculture Research Service. Available at www.ars.usda.gov.

system that is formed in the lining of the gut. As microbes ferment fiber, short-chain fatty acids and other metabolites are produced.[42] Through these mechanisms, fiber is associated with beneficial impacts on obesity, diabetes, inflammatory bowel disease, and cardiovascular disease. Functional fiber, such as resistant starch, has been approved as a food ingredient by the Food and Drug Administration (FDA) and is being added to many food products. Because of these beneficial physiological effects, health claims attributed to dietary fiber are allowed on the food labels.

Calcium and Vitamin D Low vitamin D intake is associated with decreased calcium bioavailability. Combined with low dietary calcium intake by about a third of adults, especially women, this leads to loss of calcium from bones, which, in turn, leads to osteopenia—and progression to osteoporosis.[43] The mechanism behind this is that vitamin D assists calcium absorption from the gut, calcium resorption from bones by osteoclasts, and decreases renal excretion of calcium and phosphate. Both vitamin D intake and dermal synthesis from sun exposure contribute to serum levels. The substitution of other beverages for milk, which is high in calcium and enriched with vitamin D_3 (the most available form of vitamin D), contributes to the fact that 50 percent of the population has low serum 25 hydroxy (OH) vitamin D.[44] Recent studies, recognizing vitamin D

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as an immunoregulatory hormone, are investigating its microbial and anti-inflammatory effects, particularly on the immune and cardiovascular systems.[45]

Vitamin A and Vitamin E Vitamin A and vitamin E are fat-soluble vitamins with strong antioxidant functions. Oxidation reactions produce free radicals, which start chain reactions that damage cells. Antioxidants terminate these chain reactions. The roles of vitamin E and vitamin A in DNA transcription have led to investigation of their potential protective effects in various cancers.[46] Both are also involved in the functioning of the immune system.[47] Vitamin A is essential in maintaining the integrity of the skin and mucosal cells, which function as a mechanical barrier and defend the body against infection. Vitamin A also plays a central role in the development and differentiation of white blood cells that defend the body against pathogens.[48] Vitamin E has anti-inflammatory properties and is involved in maintenance and repair of cellular membranes.

Choline Choline comes from the diet (eggs and meat are good sources) and it is synthesized in small amounts within the body. Dietary deficiency has been shown to cause fatty liver and muscle deterioration. Choline and its derivatives serve as components of cell membranes and as a precursor of the neurotransmitter acetylcholine, which signals between neurons and is involved in brain function.[49] Along with folate and vitamin B_{12}, choline is involved in the conversion of homocysteine to methionine, suggesting a role in cardiovascular disease; and it is a methyl donor during RNA replication and gene expression.[50]

Potassium and Sodium Sodium is of concern because of overconsumption, while potassium intake is low. Sodium and potassium have opposing effects on blood vessels. High sodium decreases vasodilation and raises blood pressure, and potassium increases vasodilation.[51] High dietary potassium intake is associated with low blood pressure and is recommended for primary prevention of hypertension, but potassium supplementation does not appear to have added benefit. Research using the DASH diet—high in fruits and vegetables and low-fat dairy products (all good sources of potassium) and low in sodium (2,400 mg per day)—was found to prevent and reduce high blood pressure.[52]

Magnesium Magnesium is a cofactor in cellular and tissue integrity, mitochondrial energy production, and protein synthesis. It is essential for normal metabolism of calcium and potassium, and intracellular electrolyte balance with phosphorus. Dietary pattern and intake of other nutrients affect the absorption, utilization, and excretion of magnesium. Increased consumption of refined foods and phosphate additives in processed foods and soft drinks has been associated with magnesium inadequacy. Serum magnesium levels are not a good indicator of low body stores; thus, deficiency goes undetected.[53] Subclinical deficiency is involved in the pathogenesis of chronic inflammation, which has been associated with intakes below the 50 percent of the RDA,[54] and contributes to the occurrence of cardiovascular disease, osteoporosis, diabetes, and cancer.[53] Eating a small handful of peanuts (¼ cup) daily is an easy way to increase magnesium intake.

Iron Sustained low dietary intake of iron leads to depletion of iron stores, reduced synthesis of hemoglobin, and iron-deficiency anemia with decreased oxygen transport to tissues. Iron depletion, with or without anemia, is associated with lower work performance, athletic performance, cognitive function, reproductive function (Chapter 2), and reduced immune function. Premenopausal women may have low iron status due to losses in menstrual blood. Obesity has been found to have a dysregulating effect on iron homeostatis.[55]

16.5 Dietary Recommendations for Adults

Knowing about nutrients and their roles in health and disease is one thing; but how is that translated into foods adults should eat? This is where dietary guidance systems come in. **Dietary guidance systems** are sets of dietary and lifestyle recommendations, based on the latest scientific evidence related to nutrition and health that are developed to promote health and prevent disease. They include technical reports of the scientific evidence, recommendations on types and amounts of food to eat, and tools and resources to help the public and professionals put recommendations into action. Another component of dietary guidance systems is recommendations for community action and policy changes to help create an environment where achievement of the dietary and lifestyle recommendations is possible.

Guidelines are updated periodically in response to priority health issues, new research, current nutrient intakes, and eating patterns of the population. They also take into account changes in the food system and the hospitality industry, and food product development. More recently, issues related to sustainability of the food system and environmental impacts of dietary recommendations and food choices are being raised in the decision process.[56,57] The ***Dietary Guidelines*** *for Americans* and MyPlate are

dietary guidance system A comprehensive set of dietary and lifestyle recommendations, based on the latest scientific information, that are developed to promote heath and prevent disease or its complications, ensure adequate intake of nutrients of concern, and offer guidance on what and how much to eat.

Dietary Guidelines A report, including scientific information and rationale, on dietary information and guidelines for the general public or a defined subpopulation. The guidelines provide a cohesive set of recommendations that are adopted by the government or organization. They represent policy and are integrated into food, nutrition, and health programs.

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major components of the U.S. dietary guidance system.[30,58,59] (Refer to Chapter 1 for background information.) They are the foundation for U.S. nutrition policy and for federal nutrition program regulations and education activities.

Voluntary (i.e., nonprofit) health organizations also make science-based dietary recommendations for healthy adults related to the organization's mission. See for example, the American Cancer Society Guideline for Diet and Physical Activity[60] and the American Heart Association Diet and Lifestyle Recommendations.[61] Along with the Dietary Guidelines for Americans, these guidelines identify an urgent need to address obesity and are generally consistent in their dietary advice to adults. They encourage adults to do the following:

- Consume greater amounts of fruits and vegetables, whole grains and fiber, and low-fat dairy; and reduce refined carbohydrates.
- Avoid *trans* fats and limit saturated fat intake; and select nontropical plant oils to replace saturated fat.
- Select fish, seafood, meat alternatives (nuts, seeds, beans, tofu), poultry, and lean meats; minimize red meat and avoid processed meats.
- Select more nutrient-rich food and less nutrient-poor food.
- Limit sugar, especially beverages with added sugar and grain-based desserts.
- Prepare or choose food with little or no salt.
- Get regular physical activity; and minimize sedentary time.
- Balance energy intake with energy expenditure to maintain or achieve a healthy weight.

total diet approach Guidance based on overall eating patterns that meet needs with a variety of foods over time.

nutrient-dense food A food that provides substantial amounts of vitamins, minerals, and other biologically active food components with relatively few calories. Also called nutrient-rich.

Total Diet Approach

Beginning with the 2010 Dietary Guidelines for Americans and USDA Food Patterns, a **total diet approach** was adopted.[62] This approach recognizes that food choices vary from day to day and across seasons. The aim is the selection of a combination of foods and beverages that provide energy and nutrients and meet an individual's nutritional requirements, on average, over time. There is no assumption that every day is the same; rather, selecting a variety of foods within each food group and from day to day helps assure all nutrient needs are met. Additionally, this enables choices to reflect personal preferences, cultural traditions and budgetary constraint as is a key point in the 2020–2025 Dietary Guidelines.[58]

Three "typical" food patterns have been identified for providing guidance: the Healthy U.S. style, Mediterranean style, and Vegetarian style. Using resources available at MyPlate.gov, adults can determine calorie needs and access a corresponding food plan that specifies the amount of each food group necessary to achieve nutrient adequacy for their calorie level, and then translate that into food choices and personalized menus. The goal is a nutrient-rich total diet—a balanced grouping of a variety of foods among all the food groups, consumed in moderation—that is culturally appealing, offers pleasurable eating experiences, and promotes health among Americans. Which woman in the photos is taking a step toward to meeting these goals? (Photo 16.1)

There are two important cautions when applying the USDA food patterns to yourself and other adults.

1. *Choose* **nutrient-dense foods.** The recommended amounts in the USDA food patterns assume that all choices are nutrient-dense forms without



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Photo 16.1 Contrast of eating choices.

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added sugar and keep oil within the recommended amount. The dilemma is that nutrient-dense food choices are available in the marketplace, but they often are not the form typically consumed. When "typical" rather than "ideal" nutrient-dense food choices are made, energy, total fat, saturated fat, cholesterol, and sodium exceed limits in all USDA patterns, often by substantial margins, even when the recommended quantity is selected. Consider for example: a fried, breaded chicken patty on a white bun; fries; and soda versus a grilled skinless chicken breast on a whole-grain bun, green salad, and low-fat milk. A study found that with typical choices, calories were 15–30 percent (350–450 kcal) above the target calorie level for each pattern. However, goals for adequacy of nutrients were not substantially affected by the use of typical food choices.[63]

2. *Don't eat too much.* Portion sizes specified by MyPlate are smaller than the amounts in conventional food packaging and as commonly served in restaurants. Foods must be chosen, keeping in mind recommended serving sizes and amount per day or week rather than the amount in a package or the amount served. Large serving sizes increase calorie intake and also contribute more fat and added sugar.[58] Calorie, fat, and sugar intake can be minimized by selecting fewer and smaller portions of energy-dense foods and replacing with foods of lower energy density.[64,65]

A nutrient-rich, calorie-balanced diet can be implemented in many ways to meet cultural and taste preferences. Systemic reviews of research point to three eating "styles" associated with the positive impacts on heart disease, cancer, and diabetes—the DASH diet (featuring fruits and vegetables, low-fat dairy, and low sodium), the Mediterranean style of eating (featuring vegetables, fish and seafood, and olive oil), and vegetarian diets (featuring fruits and vegetables and meat alternatives).[30] What these eating styles have in common is a shift toward a more plant-based, lower-sodium diet that includes a moderate amount of healthy fat. The USDA food plans include a typical U.S. pattern containing meat as well as a vegetarian plan to provide guidance to current vegetarians or those interested in shifting to a plant-based diet.[58]

Water Intake Recommendations

The Food and Nutrition Board defines the adult adequate intake (AI) level for water based on median total water intake (from fluids and food) from NHANES III data for young adults aged 19–30 years.[66] The panel did not set an upper level for water; however, water toxicity can occur.

Total Water AI for Adults

Men	3.7 L	(125 oz)
Women	2.7 L	(91 oz)

Drinking water and other beverages supply about 80 percent of total water needs of adults, and the moisture in food provided the remaining 20 percent.[66] Under normal circumstances, the combination of thirst and typical behaviors, such as drinking beverages with meals, provides sufficient total water intake; however, additional fluids may be needed in prolonged, intense exercise.[67]

Beverage Intake Recommendations

Beverage intake came under the spotlight in the 2020–2025 Dietary Guidelines where they were recognized as a top source of added sugar and excess calories (providing 18 percent of energy intake for adults 20 to 64 years).[30] The top calorie contributors include regular soda, energy and sport drinks, and fruit drinks; alcoholic beverages; coffee and tea; followed by milk; and 100 percent fruit juices.[68] Beyond significant calories and sugar, coffee drinks, flavored with syrup and topped with whipped cream, take a big bite out of the allowance for added fats. Sugar-sweetened beverage consumption is associated with adiposity, metabolic syndrome, and fatty liver disease. "Diet" soda is not the answer—while believed safe in moderate amounts, the safety of noncaloric sweeteners remains controversial.[30] Another issue is that calories consumed in liquid form may have less satiety value and may not be compensated for with adjustments in food intake.[69] Except for milk and 100 percent fruit juices, beverages contribute little to essential nutrient needs. To meet fluid needs while managing calories and contributing to nutrient needs, a plan for daily beverage selections could be:

- Choose water as the preferred beverage, 3–5 twelve-oz containers.
- Drink coffee or tea, up to 3–5 cups, but avoid sweeteners and fat.
- Drink two 8-oz glasses of low-fat milk.
- Drink a small (4-oz) glass of 100 percent fruit or vegetable juice, or choose fresh fruit.
- Avoid sugar-sweetened soda; if using diet soda, limit to one 12-oz can.

Resources such as the Centers for Disease Control and Prevention's (CDC's) "Rethink Your Drink" help consumers make smarter fluid selections.[70]

Caffeine and Coffee Intake

What about fluids containing caffeine? Occasionally, someone suggests that coffee, tea, or other caffeine-containing beverages not be counted as fluid intake because they have a diuretic effect on the body. Caffeine temporarily increases urine production at high doses, but no evidence connects these beverages with dehydration.[71] The Food and Nutrition Board concluded that caffeine-containing beverages contribute to daily total water intake.[66]

Caffeine is known for its stimulating effects on the central nervous system, but other biologically active compounds in regular and decaffeinated coffee exert anticarcinogenic, antimicrobial, neuroprotective, and hypoglycemic effects that may protect against liver disease, cancer, dental caries, Parkinson's disease, diabetes, and weight gain. How coffee is grown, roasted, and brewed affects its taste and aroma,

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as well as its content of caffeine and other bioactive compounds. Naturally occurring caffeine routinely consumed by healthy adults in the range of 400–800 mg/dL has not been found to be harmful and is associated with the above positive effects.[71] However, products supplemented with caffeine are proliferating in the marketplace, raising concern about its safety at high levels of intake. Adverse effects of high doses include increased heart rate and blood pressure and headaches and depend on individual sensitivity.[71]

Alcoholic Beverages

Alcohol is a popular beverage with significant social and cultural significance, but it is also a psychoactive drug with potential for abuse. Moderate alcohol intake was previously recognized as a contributor to heart health; however, new data analyses are questioning that protective association. The list of detrimental effects of alcohol is long; and there is heightened concerned about the impact of binge drinking, especially among younger adults, and its association with intentional and unintentional injuries.[72] Routine drinking of alcohol increases the risk of oral, esophageal, stomach, liver, pancreatic, and colorectal cancers, breast cancer in women, pancreatitis, coronary heart disease, sexually transmitted disease, HIV, preterm birth,[72] and it adds calories.

Approximately 56 percent of adults in the United States report alcohol consumption in the previous month, with the highest rates among people aged 21–26 years (67.6 percent) and 26–44 years (61.5 percent).[72] Rates of alcohol consumption decline with age. The U.S. guideline is: "If alcohol is consumed, it should be consumed in moderation," defined as no more than two drinks for men, and no more than one drink for women on days when alcohol is consumed.[58]

What is a drink? A drink contains roughly 13–15 g of alcohol or 0.5 oz of ethanol (Table 16.7). And it adds "empty" calories, even more if mixers are used.

Dietary Supplements and Functional Foods

Over half of adults take dietary supplements (refer to definition on Table 16.8) and about a third routinely take a multivitamin-mineral supplement to improve or maintain health. According to NHANES data, taking supplements increased overall nutrient intake and decreased the prevalence of nutrient inadequacy across all population subgroups, and significantly improved intake of the under-consumed nutrients (refer to "Risk Nutrients" in this chapter). This benefit was greatest for low-income individuals.[73]

functional food A food product that has a physiological benefit or reduces the risk of chronic disease beyond basic nutritional functions.

phenolic compounds A large group of naturally occurring compounds in plant-based foods that contribute sensory qualities to food and heath promoting benefits to the body. Also called polyphenols.

Table 16.7 Alcoholic beverages: Alcohol and calorie content

Amount	Beverage	Alcohol Grams	Calories
12 oz	Regular beer	13	153
12 oz	Light beer	12	100
1.5 oz	Distilled spirits: gin, whiskey, rum, vodka	15	90
5 oz	Red wine	15	125
5 oz	Dry white wine	14	107
2 oz	Sherry	9	80

Botanical and herbal supplements are used by about 7 percent of adults to "treat" or "prevent" a particular health-related concern. Research on their efficacy and safety is lacking; moreover, the research is challenging to do because of variations in the growing, extraction, manufacturing, and marketing of these products. For science-based information about an herbal remedy or supplement, a reliable source is the Office of Dietary Supplements website.[74]

Numerous products are available that blur the lines among supplement, therapeutic agents, and conventional food. **Functional food** is the term used for food products or ingredients that have a physiological benefit beyond the nutritional value provided. These cover many categories, as defined in Table 16.8.[75] Functional foods is a rapidly growing area driven by industry's creativity and marketing and consumer's interest and demand.

Phenolic Compounds: Everyday Functional Foods

There is an expanding body of research linking biologically active components of conventional food, specifically plant-based foods, to immune function, antioxidant and anti-inflammatory effects, and to chronic-disease risk reduction.[76] The message "choose a rainbow" of fruits and vegetables, and the popularization of the health benefits of red wine, chocolate, and spices and herbs used in cooking (such as cinnamon, ginger, cayenne pepper, garlic, turmeric) are linked to that.[77] Driving this movement is greater understanding of **phenolic compounds**—hundreds of compounds (such as flavonoids, resveratrol, coumarins, and anthocyanins) that give fruits, vegetables, herbs, and spices color, flavor, aroma, and texture, and have vital roles in the body.[78] Refer to Table 16.9 for plant foods with the highest concentrations. The natural phenolic compounds in food interact synergistically together and with other nutrients to stimulate and upregulate the body's defence systems against inflammation and oxidative stress. Thus, consumption of polyphenols directly from plant food sources is more effective than taking synthetic supplements.[76] Moreover, it adds to our eating enjoyment while having a positive effect on health.

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Table 16.8 Definition and examples of supplements and functional food categories

Category	Definition	Examples
Supplement	Vitamin, mineral, amino acid, herbal or other botanical, or combination ingested in pill, capsule, or liquid form	Multivitamin Calcium Glucosamine and chondroitin Amino acids
Functional Food Category		
Conventional foods (whole foods)	Unmodified food rich in bioactive components that have health benefits	Nuts reduce risk of heart disease Cruciferous vegetables reduce risk of cancer Flaxseed oil for omega-3 fatty acids
Modified foods • Fortified • Enriched • Enhanced	• Bioactive component added • Replacement or addition of component naturally in the food • Food product formulated with bioactive components	• Calcium-fortified orange juice, iodized salt • Flour enriched with vitamins and iron • Margarine with plant stanols or sterol esters for cholesterol lowering • Energy bars, yogurt, or bottled water formulated with amino acids, lutein, fish oil, probiotics, ginkgo biloba, caffeine
Medical foods (available only by prescription)	A food formulated to be used under the supervision of a physician, intended for the specific dietary management of a disease or condition	Phenylketonuria (PKU) formula free of phenylalanine
Foods for special dietary use (available at the retail level)	Food designed to meet a special dietary need due to physical, physiological, pathological, or other condition; supplement the diet; or replace a meal or daily food intake	Gluten-free foods Sports drinks with electrolytes Nutrient-dense beverage for protein and calorie supplementation Meal replacements for weight-reducing diets

Source: Based on C. M. Hasler, et al. Position of the American Dietetic Association: Functional foods. *J Am Diet Assoc.* 2009; 109:735–746.

Table 16.9 Examples of foods with high phenolic concentration

Source	Food with Highest Phenolic Content	Total Phenolics (mg per 100 g)
Cereals and legumes	Soybean, oat, wheat flour	414–184
Vegetables	Red cabbage, potato, kale, spinach	186–112
Fruit	Orange, raspberry, kiwi, grapefruit, blueberry, plum, sweet cherries	1,343–342
Herbs	Basil, shallot, thyme, red onion, mint	4,425–400
Spices	Cloves, pepper, coriander, ginger, turmeric	1,600–176
Other	Roasted coffee bean, cocoa liquor, alkalized cocoa powder	1,305–896
Beverages	Red wine, coffee, tea	242–83
Nuts	Walnut, pistachio, peanuts, pecan	2,499–576

Source: Adapted from Maria de Lourdes Reis Giada. Food phenolic compounds: main classes, sources, and their antioxidant power. Chapter 4 in Oxidative Stress and Chronic Degenerative Diseases—A Role of Antioxidants, 2013. doi: http://dx,doi.org/10.5773/51687.

The Eating Competence Model

Eating behaviors begin within the individual and their beliefs and attitudes about food and eating. The **Eating Competence Model** offers a paradigm for nutrition education and dietary guidance that is different from but complementary to dietary guidelines that are focused on risk reduction. This model recognizes the special value of the social and sensory aspects of food and eating. The goal is to encourage "competent eaters who are positive, comfortable, and flexible with eating and are matter-of-fact and reliable about getting enough to eat of enjoyable, nourishing food."[79]

The model has four components:

1. **Eating attitudes:** Includes positive interest in foods and eating; self-trust about managing food and eating; and finding harmony among food desires, food choices, and amounts eaten.

Eating Competence Model A paradigm for nutrition education and dietary guidance that considers four components: eating attitudes, food acceptance, regulation of food intake, and eating context. A competent eater is positive, comfortable, and flexible with eating and is matter-of-fact and reliable about getting enough to eat of enjoyable, nourishing food.

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Table 16.10 Cues for regulating food intake

Appetitive Cues	Physical Sensation	Emotional Feeling or Cognition
Famished	Extreme hunger, pronounced discomfort: shakiness, crankiness, headache	Urgency and desperation to eat Often results from food insecurity (no assurance of being able to get enough to eat) May result from extreme self-restraint
Hunger, increased appetite	Physical experience of emptiness; may include mild discomfort	Tolerable anticipation of eating Awareness that adequate amounts of rewarding food will soon be available
Hunger goes away	Physical feeling of emptiness subsides, along with discomfort from energy deficit	Sense of relief increases; however, most people are reluctant to stop eating at this point because eating is still rewarding
Appetite goes away	Satiety: positive experience of readiness to stop eating This is a more sustaining and rewarding endpoint to eating for most people than when hunger goes away	Food stops tasting good; a subjective experience of losing interest in eating
Feeling full	For most, this is a pleasant, if occasional, endpoint to eating; it is a positive state of feeling filled up	Eating past satiety is rewarding if it follows a deliberate decision to eat more than usual, perhaps on a ceremonial occasion, because food tastes exceptionally good or because energy needs have suddenly increased
Feeling stuffed	Negative physical state, including extreme fullness, lethargy, physical discomfort, perhaps nausea; virtually universally experienced as being a negative endpoint to eating	Accompanied by a sense of chagrin at overeating and self-indulgence; often arrived at as an unthinking or impulsive suspension of self-restraint

Source: Based on Satter Eating Competency Model.

2. **Food acceptance:** Recognizes that enjoyment and pleasure are primary motivators for food selection, and that nutritional excellence is supported by enjoyment of a variety of food, including nutritious food. Food acceptance means being comfortable eating a preferred food, even if it isn't the most nutritious, but it also means being able to settle for less-preferred food when necessary to satisfy caloric or other nutritional needs.
3. **Regulation of food intake:** Emphasizes internally regulated eating and attention to sensations of hunger and fullness. Refer to Table 16.10 for hunger-related cues.[80] One who has learned self-regulation has the ability to tolerate hunger when there is confidence that adequate, rewarding food will be available; the ability to stop when satisfied; and the ability to accept the body weight that evolves from internally regulated eating.
4. **Eating context:** Puts priority on structure and meal planning. Meals are a predictable time to eat adequate amounts of preferred food. Eating is intentional and deliberate, and it requires discipline. The model teaches that going to some trouble to procure rewarding food, scheduling eating times, and setting aside time to eat are important. Intentional, deliberate eaters are able to postpone snacking and grazing when they are confident that there will be satisfying food at the next meal.

Within the eating competence model, nutrition education and dietary guidance are used to help people be more attuned to their needs and feelings; to encourage them to try and learn to like a wide variety of nutritious foods; and to remind them of the importance of taking time and having the self-discipline to plan and prepare satisfying meals.

16.6 Physical Activity Recommendations

Healthy eating and increased physical activity are the featured duo for combating obesity at the individual and population level and are primary and secondary prevention strategies for several chronic diseases, including cardiovascular disease, diabetes, hypertension, osteoporosis, several types of cancer, and depression.[9,30,58,60,61,81] Physical activity increases muscle strength, balance, and endurance, and cardiorespiratory fitness; it supports physical and mental health and improves cognitive function; and it helps manage weight and reduces risk factors for disease including high blood cholesterol and blood pressure. In contrast, higher amounts of sedentary behavior (sitting, reclining, or lying) is associated with greater incidence of cardiovascular disease, cancer and type 2 diabetes and poor health outcomes. Regular physical activity and resulting fitness enables adults to meet the physical

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demands of daily living, work, and leisure and enhances quality of life.[81]

Guidelines for Physical Activity

Any physical activity is better than none; even short episodes of physical activity above usual activity can have positive health benefits.[81] Benefits, including reduced blood pressure and anxiety symptoms and improved sleep and cognition, happen immediately. The degree of benefit increases as the volume (duration) and intensity increase.[81] Current guidelines strongly recommend that adults reduce sedentary time and integrate moderate to vigorous intensity physical activity into their routine lifestyle.[82] The target amount of physical activity for substantial health benefit is 2.5 hours per week (Table 16.11).[82]

The basic recommendation could be met with a brisk 30-minute walk 5 days a week, or two to three 10-minute bouts of activity every day. Surveys indicate about half of adults were meeting these guidelines (with greater participation by younger adults, men, non-Hispanic Whites, and those with greater education), but a quarter of adults reported they never do moderate or vigorous physical activity.[83] World Health Organization (WHO) guidelines emphasis that physical activity guidelines also apply to adults living with chronic disease or disabilities, and underscore actions to assure everyone has access to the benefits of physical activity adapted to their needs.[84]

Table 16.11 Physical activity guidelines for Americans: Adults (aged 18–64)

- **Basic recommendation:** Two hours and 30 minutes a week (150 minutes) of moderate-intensity, or 1 hour and 15 minutes a week (75 minutes) of vigorous-intensity aerobic physical activity, or an equivalent combination preferably spread throughout the week. Short duration activity can be accumulated to reach this target.
- **For additional health benefits:** Increase to 5 hours (300 minutes) a week of moderate-intensity aerobic physical activity or 2 hours and 30 minutes (150 minutes) of vigorous-intensity physical activity.
- **Muscle strengthening:** Adults should also do muscle-strengthening activities that involve all major muscle groups (legs, hips, back, abdomen, chest, shoulders, and arms) on 2 or more days per week.

Moderate or vigorous intensity?
Take the talk test:

If you can talk, but not sing, you are doing moderate-intensity activity.
If you can't say more than a few words without pausing for a breath, you are doing vigorous-intensity activity.

Moderate-intensity activity examples:

Baseball, brisk walking, cycling, golf (carrying bag), raking leaves, vacuuming, water aerobics

Vigorous-intensity activity examples:

Aerobic exercise classes, basketball, fast dancing, hiking with backpack, jumping rope, running, swimming laps

Promotion of Physical Activity

Overcoming a sedentary lifestyle is a challenge. Habitual physical activity starts with intentional, repetitive actions that become enjoyable, rewarding, and outweigh alternative uses of time. Personal (e.g., time, motivation, skill), social, and environmental factors influence the degree to which physical activity is a routine part of lifestyle. Socioeconomic constraints, cultural preferences, sedentary work and leisure time, and obesity and health concerns are barriers. To address these barriers and reach different population groups, many effective and sustainable strategies have emerged. These include community, school, and worksite programs; social support interventions such as buddy systems and walking groups; computer-tailored individualized physical activity prescriptions; wearable activity monitors, smartphone apps, and Internet sites for tracking, and reinforcement; accessible walking trails and recreational facilities, and the addition of culturally sensitive exercise programs within existing facilities and programs.[82,84]

Widespread efforts to change the environment to foster a variety of opportunities for physical activity and accommodate a wide range of preferences and abilities have developed into the **active living movement**. Joint efforts across public and private sectors have led to changes that span community attitudes and expectations, government planning and zoning regulations, and building and transportation infrastructure that together moderate sedentary lifestyles and enable greater physical activity in all aspects of life.[85]

Healthy People 2030 objectives for physical activity are targeted to promote physical activity in all the ways just mentioned and to encourage health-care providers to routinely assess physical activity levels and provide counseling and education about physical activity.[9]

Physical Activity, Body Composition, and Metabolic Change

Individuals who are habitually sedentary should progressively increase the duration and intensity of regular physical activity to allow for adaptations in capacity and efficiency of the body's structures and functions (e.g., cardiorespiratory fitness and muscle strength).[82] Favorable body composition changes (reduced fat mass and increased lean muscle mass) occur with the adoption of regular physical activity.[81] Even in the absence of caloric

active living movement Building a culture where regular physical activity and healthy eating are the accepted norm for people of all ages, abilities, and income levels. Involves partnerships of public and private entities and the local community to bring about changes.

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restriction, aerobic physical activity equivalent to walking at 4 miles per hour for 150 minutes a week or jogging at 6 miles per hour for 75 minutes a week results in decreases in total and abdominal adiposity that are consistent with improved metabolic function. When more physical activity is done, intra-abdominal fat losses are greater. Moreover, research indicates that abdominal fat loss is greater during exercise-induced weight loss and among those with the greatest level of adiposity.[81] Studies indicate that exercise can result in beneficial changes in circulating insulin and inflammatory biomarkers, which may explain the positive effect of physical activity on cardiovascular disease, diabetes, and cancer.[81]

Diet and Physical Activity

The concerns a person might have when starting an intensive training program are illustrated in Case Study 16.1. Healthy adults who exercise regularly and follow a healthful diet, as recommended by the Dietary Guidelines, don't need dietary modifications to support physical activity. For some starting an exercise program provides an incentive to examine and improve eating practices. Adults who engage in a strenuous exercise program or competitive sports have increased nutrient and hydration needs to meet demands of training, competition, and recovery (Table 16.12).[86] Nutritional

Case Study 16.1 Run, Jamilah, Run

Jamilah, has enjoyed physical activity and the out of doors since her teens, but she had not developed a regular routine for making physical activity a part of her life. Inspired by a group of friends, she started running and loves it! The group decided to sign up for a half marathon and have started training. Jamilah runs about 5 days a week, and monitors her miles, time, and calories using a wrist band and training app. She also gets a lot of tips from a running group on social media. Now Ramadan is coming up and Jamilah is wondering how to adjust her training while going without food and drink from dawn to dusk for 30 days. She decided to check in with the dietitian at the college health service to get some advice. Jamilah is 21 years old, 5 ft, 4 in. tall, and her weight has been stable at about 135 lb. She eats halal foods, likes meat, rice and pasta, vegetables, and fruit. She says her downfall is tea (5–6 cups/day) with lots of sugar and milk. She tries to avoid sweets but she can't turn down occasional casariyo treats.

An analysis of a 24-hour dietary recall shows the following:

2,090 cal	34 mg iron
352 g carbohydrate (67% of calories)	958 g calcium
41 g total fiber	690 mcg RAE vitamin A
98 g protein (19% of calories)	158 mg vitamin C
33 g fat (14% of calories) (7 g saturated fat, 1 g *trans* fat, 1.5 g omega-3 fatty acid, 99 mg cholesterol)	5.0 mcg vitamin D 8.7 mg TE vitamin E 586 mcg DFE folic acid
3,343 mg sodium	283 mg choline

Questions

1. How many calories does Jamilah need to maintain her weight?
2. Is she eating enough to support daily workouts?
3. Describe three health-promoting aspects of her diet.
4. Make three suggestions that could improve her diet.
5. Research shows that observant Muslims consume about the same number of calories in two meals during Ramadan as they do in regular meals the rest of the year. How will the period of daytime fasting affect Jamilah's training?



JuiceBros/iStock/Getty Images

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Table 16.12 Nutrient and fluid consideration for intensive exercise program

Macronutrients: • Carbohydrate: 6–10 g/kg (2.7–4.5 g/lb) to maintain blood glucose and replace muscle glycogen • Protein: 1.2–1.7 g/kg (0.5–0.8 g/lb) along with sufficient calories for protein sparing • Fat: 20–35% of total calories for energy and source of antioxidants Vitamins and Minerals: Supplements generally not needed if consuming a healthful diet with adequate calories. Numerous recommendations exist on performance-enhancing effect of various supplements.
Fluid: Sufficient water and other liquids for hydration and to replace sweat losses: • Weigh before and after exercise to determine sweat loss. • Drink 16–24 oz fluid for every lb (0.5 kg) of body weight lost. • Observe urine; dark color indicates dehydration. • Adjust fluid intake before, during, and after exercise to minimize or prevent dehydration.
Exercise: Impact of type of training or intensive physical activity on nutrient needs: • Endurance sport—Carbohydrate and energy needs higher to sustain blood glucose and replace muscle glycogen. • Bodybuilder training—Protein and calorie needs higher for muscle growth and repair. • Exercise or training program to improve fitness and drop body fat—Carbohydrate intake lower, moderate caloric reduction.

Source: Adapted from Position Paper of the American Dietetic Association and the Canadian Dietetic Association: Nutrition and Athletic Performance.[84]

ergogenic aids—nutritional products that are purported to enhance performance—range from caffeine beverages and protein powders to sport drinks and energy gels and bars. Studies indicate a positive effect of caffeine, primarily on aerobic endurance-type exercises;[87] however, evidence on the effectiveness of most products is lacking. In spite of the popularity of energy and sports drinks, water is sufficient for hydration for routine physical activity.[86] Trainers promote a "food first" approach (assessing and improving one's food choices and eating pattern) rather than using supplements, to support health and athletic performance.[88] The bottom line for all adults is making healthful eating and regular physical activity a routine and enjoyable part of everyday life.

16.7 Nutrition Intervention for Risk Reduction

Many strategies are used to promote nutritional health and reduce the risk for obesity and chronic disease among adults. These range from individual, client-centered interventions such as education and counseling, to multicomponent programs that take advantage of social and environmental supports, to policy and system changes that affect the quality, availability, and affordability of food and physical activity opportunities.

Nutrition intervention for adults takes place at many levels and in many settings to impact the individual as well as external factors shown in Figure 16.1. Education and counseling can be directed to the individual to increase knowledge and encourage behavior change (via numerous channels including direct contact, telehealth, and social media). Discussions about healthy weight and eating habits are becoming a more common part of primary health care. Environmental changes, such as point-of-purchase signage about calorie or fat content of foods, or healthier food options in vending and convenience outlets, are being implemented to enable healthier food choices.[89] Other interventions affect availability and access to healthful foods, such as menu guidelines for worksite cafeterias and food policies for organization-sponsored events, more community gardens and farmers' markets, and limits on the number of fast-food outlets in low-income neighborhoods. Health-promotion programs that include healthy eating and physical activity are sponsored by churches, community organizations, and employers. Community campaigns promote healthy eating messages to the general public or specific messages tailored to identified needs and risk factors within subgroups. Enrichment of commonly eaten foods with nutrients lacking in the diet is a policy intervention that changes nutrient intake without requiring nutrition education or behavior change. Implementing taxes on sugar-sweetened beverage purchases leads to a decline in consumption.[90] Reducing risk and improving the nutritional and health status of adults requires multiple strategies that combine individual-, social-, organizational-, and policy-level changes such as those mentioned.

A Model Health-Promotion Program

"Sisters Together: Move More, Eat Better" illustrates the components of a comprehensive, effective program for adults. Sisters Together, a national initiative of the Weight-control Information Network (WIN), is a health awareness program that encourages African-American women 18 years and older to maintain a healthy weight by becoming more physically active and by eating nutritious foods (Photo 16.2). It is a culturally relevant, community-based program that is flexible and can be tailored to African American women of all ages, communities, and demographics. The program design combines social marketing with community-building strategies.[91]

ergogenic aids Nutritional products that are purported to enhance performance. Examples range from caffeine and protein powders to sports drinks and energy gels and bars.

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Amanda Mills/CDC

Photo 16.2 Multicomponent programs like Sisters Together foster healthy eating.

Advances in technology and the widespread use of smartphones and social media by African American women provide additional avenues for incorporating innovation and updated approaches into programs tailored to their needs and interests.[92]

Dedicated individuals and organizations can start a program at the local level using the Sisters Together Program Guide and materials. The manual outlines the steps to creating a successful program:[91]

- Assess needs and select the audience.
- Identify community resources and partners.
- Set realistic goals and objectives.
- Work with media to raise awareness.
- Decide on core activities and events.
- Measure success.

Sisters Together initiatives bring together respected leaders and organizations in the community that have goals similar to those of Sisters Together, address women's issues and concerns, and have credibility with African American women in the community. Programs are based in settings that range from churches to beauty salons. They partner with community centers and YWCAs for group meetings or exercise classes, and link up with public programs such as WIC and SNAP. Media, including radio, newspapers and newsletters, and social media, are used to increase the visibility of the Sisters Together program, cover special events, and raise awareness about relevant issues.

Core activities are determined at the local level and are designed to fill knowledge gaps, reduce barriers, increase opportunity, provide social support, and complement other community resources. Activities are selected to match the expressed needs of women in the community such as desires to have more energy, relieve stress, look good, and feel better about themselves. Program content emphasizes how physical activity and nutrition help achieve these needs. Examples of successful activities include classes where food is prepared and tasted, featuring easy-to-prepare recipes that are low in calories, fat, and salt; and organized groups and buddy systems to support physical activity such as walking clubs and classes.

Approaches encourage physical activity versus exercise and feature traditional ethnic foods and flavors but with more health-conscious ingredients and preparation methods. Positive changes in fruit and vegetable intake and physical activity have been documented through pre- and post-evaluations. Ongoing and periodic "booster" programs are strategies to maintain changes over time.

The model of raising awareness and improving health through the establishment of community-based groups and campaigns is applicable in a wide range of adult nutrition and health issues. Multicomponent programs such as this help create a "culture of health" that supports positive diet, physical activity, and lifestyle behaviors.

Public Food and Nutrition Programs

Having a low income makes it difficult to consistently provide enough food for family members and to access a variety of healthful foods. People living in poverty tend to have poorer diets and increased rates of obesity, and adverse health outcomes.[3,9–12,30,58] Improving the food security of the population is part of the national health goal of eliminating heath disparity. Food insecurity—difficulty providing enough food for all family members at some time during the year due to a lack of resources—is a fact of life for over 10 percent of U.S. households, but impacts some segments of the population at much higher rates (Table 16.13).[93]

According to Census Bureau estimates for 2020, the poverty rate for the United States is 11.4 percent. However, there is great disparity. The rate is 8.2 percent for Whites, compared to 19.5 percent for Black Americans 17 percent for Hispanics, and 8.1 percent for Asian Americans; and, when data are available, Native Americans and Alaskan Natives have the highest rate (estimates range from 25 to over 40 percent). For adults aged 18–64 years, the rate is 10.4 percent.[94] The Census Bureau's poverty threshold was originally derived by calculating the cost of food needed for basic dietary requirements (according to

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Table 16.13 Healthy People 2030 food-security target compared to 2020 levels

Objective	Target	2020 Level
Reduce household food insecurity and in doing so, decrease hunger		
All households	6%	10.5%
Households at or below 30% of poverty		35.3%
African American, not Hispanic		21.8%
Hispanic		17.3%
White, not Hispanic		7.0%
American Indian, Alaskan Native		25.0%
Other		8.6%
Single women with children		27.8%

Sources: U.S. Department of Health and Human Services. Office of Disease Prevention and Health Promotion. Healthy People 2030. Washington, DC. Available at healthypeople.gov; Food Security and Nutrition Assistance, Economic Research Service, USDA. Available at ers.usda.gov.

the lowest cost of the USDA's four food plans) and multiplying that cost by 3. This poverty index was developed in the early 1960s by the Social Security Administration; at that time, food costs made up about one-third of the average household budget. The poverty threshold is updated annually for price changes using the CPI-U. Currently, households spend 7–40 percent of after-tax income on food. Low-income households spend disproportionately higher levels of their income on food.

For 2023, a person was considered to live in poverty if their annual income was $14,580 or less.[95] Poverty guidelines are calculated according to household size and adjusted for higher living costs in Alaska and Hawai'i. For a four-person household, the poverty guideline was $30,000 in the contiguous states and Washington, DC. The federal poverty guideline is published annually in the *Federal Register*. Multiples of the poverty guideline (125 percent, 150 percent, and 185 percent) are used to determine eligibility for food and nutrition assistance programs that are administered by the USDA.[96]

By far, the largest of all nutrition assistance programs is the Supplemental Nutrition Assistance Program (SNAP). It provides economic support for food purchases to low-income households, and promotes healthy diets through nutrition education. The effects of participation in SNAP, which rises and falls with changes in the economy and poverty rate, has been studied in various ways. While some studies indicate greater expenditures on vegetables, fruit, grain products, meat, and meat alternatives, a recent study found SNAP participants' diet score was somewhat lower than that of low-income nonparticipants.[97]

Many other programs work to help hungry individuals and families gain food security. For example:

- Government-funded university extension programs teach budgeting, shopping, meal planning, and food-safety skills.
- The Second Harvest food bank network keeps wholesome food items out of the waste stream, coordinates charitable giving programs, and supplies food shelves and community kitchens.
- Soup kitchens and shelters provide hot meals and snacks for hungry and homeless people.
- Meals-on-Wheels programs serve homebound adults. Some are funded through the Agency on Aging, but many operate as voluntary community efforts.

Together, governmental and private organizations help individuals and families gain consistent access to safe, wholesome foods that are culturally acceptable. Such access is the basis of food security.[98]

Putting It All Together

Adults need access to a variety of healthful foods, knowledge to guide food choices, and positive attitudes about food and eating, balanced with discipline. Food choices that result in nutrient adequacy and energy balance matter throughout the adult years. Good choices, a variety of nutritious foods, and not too much food intake in early adulthood years affect health and nutritional status in future years. Food and nutrient intakes, along with physical activity and other lifestyle factors, genetics, and environment, determine one's ability to maintain or restore health and minimize the development and advancement of chronic disease. The overarching message is to follow the principles of variety, moderation, and balance in choosing a diet that will be satisfying and that will achieve a healthy body weight and maintain health.

Key Points

1. Individual choices as well as external factors strongly influence the course of health and wellness for adults.
2. There are significant disparities in the incidence and prevalence of disease across population groups. Social and economic disadvantage, along with other factors, are important determinants of nutritional and health outcomes.
3. Beginning early in the adult years, bone mass begins to decline, and there is an increase in body fat that is associated with increased risk of chronic diseases.

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4. Subclinical nutritional injury begins long before observable signs and symptoms emerge. Early alterations in nutritional state can be reversed with changes in nutrition and physical activity.
5. Metabolic rate and energy expenditure decline through the adult years. Balancing energy intake and physical activity is necessary to maintain a healthy body weight. Several methods can be used to estimate energy needs.
6. Risk nutrients for adults include excessive saturated fat and sodium intake and inadequate intake of several vitamins, minerals, and fiber with important metabolic consequences.
7. Various eating patterns can be healthful, provided energy intake is not excessive, recommended amounts of nutrients are consumed over time, and nutrients are balanced to support their interdependent functions.
8. Dietary guidance systems are designed to reduce risks of specific diseases; ensure that the population consumes adequate levels of required nutrients from food and beverages; and help the public understand what, and how much, to eat.
9. Current dietary recommendations emphasize nutrient-dense foods but not too much, allow for flexibility, and recognize the social and sensory aspects of food and the importance of pleasurable eating experiences.
10. Regular physical activity has crucial effects on weight, body composition, and development of chronic diseases.
11. Reducing risk and improving the nutritional and health status of adults require multiple strategies that combine individual-, social-, organizational-, and policy-level changes.

Review Questions

1. What are the differences between individual and external or environmental factors that determine nutrition status and health? Give examples for how each type is monitored.
2. Describe the physiological changes that occur during the adult years. How do those changes relate to the continuum of health? Which changes have implications for development of chronic diseases?
3. How many calories do you need? Use three methods discussed in the chapter to estimate daily energy requirement. What factors would increase or decrease the number of calories you need to eat in a day?
4. If you are a typical man or woman as represented in Table 16.5, what nutrient shortfalls and excesses should you be worried about and why?
5. You have been appointed to the Campus Dietary Guidelines Committee. What things do you need to consider when developing dietary guidelines for the campus community?
6. What do you need to do to meet the Physical Activity Guidelines for Americans? What are the benefits if you do? What are the consequences if you don't?
7. Make a table of different types of strategies for helping adults achieve good nutritional health.

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17

Adult Nutrition

Conditions and Interventions

Prepared by Patricia L. Splett

Learning Objectives

After studying the materials in this chapter, you should be able to:

17.1 Analyze the multiple causes of obesity and how they relate to nutrition assessment and intervention for adults.

17.2 Explain how atherosclerosis is the basis for cardiovascular diseases (CVDs) and how assessment and intervention are used for prevention and treatment of CVD.

17.3 Describe metabolic syndrome and its assessment and effects.

17.4 Differentiate the types of diabetes and how they are diagnosed and managed.

17.5 Describe the development of cancer and contrast nutrition assessment and intervention priorities at each of the four stages of cancer care.

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Introduction

Lifestyle, interacting with environment, and genetics determine a person's risks and opportunities, as well as their response to them, with resulting effects on health and ultimately the cause of death. Unfortunately, accidental injury, self-harm (suicide), and homicide hold disturbingly high rankings on the list of causes of death for young adults (Table 17.1).[1] However, about half of adults will develop and eventually die from one or more nutrition-related chronic disease including obesity, heart disease, diabetes, and cancer. Diseases that develop during the adult years result from the cumulative effects of:

- Diets high in calories, saturated fats, sugar, and sodium
- Diets low in vegetables, fruits, and fiber
- Tobacco, drug, and alcohol use
- Physical inactivity

The development and progression of chronic diseases, which are commonly diagnosed at midlife (45–65 years), significantly impact the quality and length of life of adults. How young adults chose to eat and live their life affects this progression. Nutrition plays an important role in primary prevention (maintaining a healthy state) and secondary prevention (reducing risk factors and delaying advancement to overt disease), as well as treatment of the major chronic diseases.

This chapter starts with obesity and then addresses the three nutrition-related diseases that are the highest contributors to premature death among adults—cancer, cardiovascular diseases, and diabetes. The reader should recognize the interrelatedness of the chronic diseases and be alert to the risk factors that these diseases have in common, and note a core set of intervention strategies used to prevent and manage all of the nutrition-related chronic diseases.

17.1 Overweight and Obesity

Obesity is an unhealthy accumulation of body fat. In technical terms, obesity is a chronic disease involving pathophysiological processes that result in an excess accumulation of adipose tissue, which increases morbidity and mortality.[2] Adipocytes (fat cells) are not passive deposits of excess fat. They comprise an active endocrine organ that secretes hormone-like factors that play a positive role in energy homeostasis (storage and release of fatty acids for energy production). However, excessive accumulation, in amount and location, results in adipose malfunction and secretion of hormones associated with chronic low-grade inflammation and insulin resistance.[3]

Prevalence of Obesity and Overweight

The U.S. obesity rate for adults has exceeded 40 percent, and the prevalence of severe obesity (BMI >40) has increased to 11.5 percent for women and 6.9 percent for men.[4] Additionally, another third of adults are overweight. This represents a dramatic change in body composition over a generation. In 1990, the obesity rate across the United States ranged from less than 10 to 15 percent. Now, overweight or obesity is a common condition among adults.

Obesity has increased in all segments of the population, but differences are evident when considering age, gender, race/ethnicity, income categories, and geographic region.[4] For example, based on 2018–2020 data, young adults aged 18–24 years had the lowest self-reported obesity (19.5 percent) compared to adults aged 45–54 years who had the highest prevalence (38.1 percent); the prevalence in non-Hispanic Black women was 56.9 percent; and states in the Midwest and South had the highest rates at 34.1 percent. While only three states had rates in the 20 percent to 24 percent range.[5]

Table 17.1 Leading causes of death by age group, 2019 and 2020

	25–34 Years	35–44 Years	45–54 Years	55–64 Years	All Ages 2020
1	Accidents	Accidents	Cancer	Cancer	Heart disease
2	Suicide	Cancer	Heart disease	Heart disease	Cancer
3	Homicide	Heart disease	Accidents	Accidents	COVID-19
4	Cancer	Suicide	Liver disease	Respiratory disease	Accidents
5	Heart disease	Homicide	Suicide	Diabetes	Stroke
6	Liver disease	Liver disease	Diabetes	Liver disease	Respiratory disease
7	Diabetes	Diabetes	Stroke	Stroke	Alzheimer's disease
8	Stroke	Stroke	Respiratory disease	Suicide	Diabetes
9	Pregnancy childbirth	Influenza	Kidney disease	Kidney disease	Influenza
10	HIV	Septicemia	Septicemia	Septicemia	Kidney disease

Source: National Center for Health Statistics. Deaths: Leading Causes for 2019, and Leading Causes of Death for 2020.

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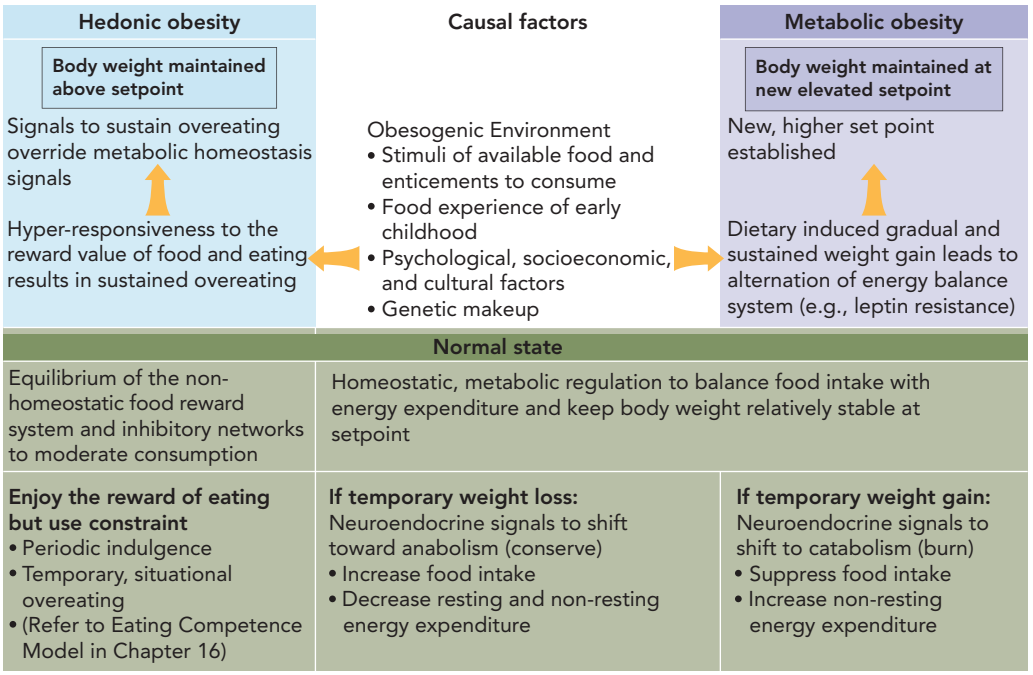


Figure 17.1 Mechanism of weight gain leading to metabolic and hedonic obesity.

Source: Figure 1 (Metabolic and hedonic obesity) from Yu, Y-H., et al. Metabolic vs. hedonic obesity: a conceptual distinction and its clinical implications. *Obesity Reviews*. 2015; 16:234–247 (p. 236).

Etiology of Obesity

Overweight and obesity are not simply a matter of intake exceeding output. They are complex and chronic conditions, stemming from numerous interacting physiological, individual, environmental, and genetic factors. These factors affect the type, frequency, quantity of food and beverages consumed, and the body's metabolic processes. Over the past decade, research on the gut-brain axis has elucidated a greater role for gut microbiota in appetite regulation and obesity. Gut microbiota influence the release of several metabolites and hormones (predominantly short-chain fatty acids, serotonin, peptide YY, ghrelin, and ligands) that communicate from the gastrointestinal tract to the appetite regulatory centers in the brain through nerve signaling pathways, or through blood circulation. Researchers are investigating how changes or differences in microbial composition may affect regulation of metabolism, adiposity, homoeostasis, and energy balance as well as central appetite and food reward signaling, which together have crucial roles in obesity.[6]

Physiological and psychological mechanisms are involved in weight gain leading to obesity, which can be characterized as metabolic or hedonic obesity. Figure 17.1 contrasts these mechanisms with the normal state.[7]

Normally body weight is determined by a neuroendocrine regulatory system that tends to maintain weight at a relatively stable "set point" through homeostatic feedback processes. Leptin, insulin, gut hormones, and levels of other metabolic products signal anabolic or catabolic responses, adjustment of resting energy expenditure, appetite, and food intake. **Metabolic obesity** occurs when an individual's set point shifts and stabilizes at a higher weight level. Genetic and environmental influences, including food experiences in infancy and childhood, are causes. **Hedonic obesity** occurs when the energy homeostatic signals are overridden by hyper-responsiveness to the reward value of food. These mechanisms behind weight gain and obesity distinguish between the metabolic brain responsible for homeostatic regulation, and the cognitive and emotional brain, which responds to perceived pleasantness, liking, wanting, and reward.[7]

Backing up a step, what is the cause behind these altered obesity pathways? Genome research has led to the identification of numerous obesity susceptibility genes associated with measures of adiposity.[8] Epigenetic factors (e.g., bioactive dietary components, physical activity, sleep patterns, and environmental exposures including fetal exposure) can affect gene expression and determine an individual's susceptibility to metabolic alternations, weight gain, and potential responsiveness to weight management strategies.[9] Phenotypes (i.e., observable traits that result from interactions between genetics and the environment)

metabolic obesity Body weight set point shifts to a higher level due to alterations of the energy balance system.

hedonic obesity Body weight maintained above set point due to sustained overeating.

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reflect present, past, and ancestral environments and help explain individual variation in why some people are obese yet "metabolically healthy" and some people are normal weight, but laboratory tests indicate they are "metabolically obese.[9,10]

Studies using nutrigenetic analyses and nutrigenomic approaches in specific population groups, have identified genetic association with differences in body composition (body mass index [BMI], abdominal obesity) and response to diet, and have found that consumption of specific dietary components and adherence to healthy eating patterns may attenuate the genetic association with weight.[10] This line of research opens the door to precision approaches for preventing and treating obesity. The emerging field of **precision nutrition** recognizes genetic and metabolic heterogeneity and involves stratifying people into subgroups based on biomarkers, as well as dietary intake, other behaviors, and socioeconomic and physical environment factors, thereby enabling more personalized dietary recommendations and interventions.

At the individual level, genetic factors interact with other factors involved in the development of obesity. Psychological, socioeconomic, and cultural factors play a role in shaping attitudes, behaviors, and lifestyle patterns. Stress, anxiety and depression, and life-changing events such a transition to college life[11] and pregnancy are associated with weight gain. Information regarding obesity among gender minorities is lacking. Transgender and gender non-conforming individuals may have unique risk factors for obesity, including hormone replacement therapy, psychosocial risk factors related to depression, and socioeconomic risk factors related to housing and job insecurity. These factors have important implications for screening and management of overweight and obesity in this population.[12]

At the community and population level, the prevailing **obesogenic environment** seems to stack the deck against controlled eating. Food advertising, the easy availability of highly palatable and highly processed, energy-dense snack foods and beverages, larger retail package sizes, larger portions served in fast-food and sit-down restaurants, the relatively low cost of fast food, and the added fat and sugar in many foods work against healthy eating and contribute to the obesity epidemic.[13] Technological advances in every dimension of life—work, leisure time, transportation—have replaced physical activity with sedentary activity and further contributed to the obesity epidemic.[3]

Thus, the causes of obesity are complex and involve multiple interacting factors. Egger and Dixon describe layers of influence from lifestyle and environmental "inducers" that incite low-level, persistent, systemic inflammation in susceptible individuals.[14] Obesity has been linked to other diseases through adipose-related inflammation. It is postulated that inflammation can arise in direct response to nutrition, inactivity, stress, technology, inadequate sleep, the built environment, occupation, drugs, smoking and alcohol, sunlight exposure, relationships, and social factors. This low-grade inflammation is an independent determinant of many chronic diseases, including obesity.[14]

precision nutrition An approach to developing more targeted and effective diet interventions based on an individual's personal genetic and metabolic characteristics.

obesogenic environment The sum of influences that promote overeating and minimize physical activity and lead to weight gain and hinder weight loss.

Effects of Obesity

Being overweight or obese increases the risk of pathological conditions in most organs of the body, and is related to development of a long list of conditions (Table 17.2). The risks rise as the degree of excess adiposity rises. Beyond the cardiometabolic conditions, people who are obese might have physical disabilities, which interfere with the routine activities of daily living, and they may face psychosocial complications, including low self-esteem and depression, social and job discrimination, and social stigma.[15] Life expectancy is shortened by 6–19 years, depending on the severity of obesity.[16]

Table 17.2 Conditions associated with overweight and obesity

Cardiometabolic Conditions	Biomechanical Conditions	Other Conditions
Cardiovascular disease	Disability and immobility	Some cancers (endometrial, breast, prostate, colon)
Dyslipidemia	Gastrointestinal reflux disease	Depression and other psychological disorders
Hypertension	Musculoskeletal disorders	Gallbladder disease
Metabolic syndrome	Osteoarthritis	Infertility
Nonalcoholic liver disease	Sleep apnea	Male hypogonadism
Prediabetes	Urinary stress incontinence	Respiratory problems
Type 2 diabetes mellitus		Social stigmatization
Polycystic ovary syndrome		

Source: Adapted from AACE/ACE Clinical Practice Guidelines for Medical of Patient with Obesity, 2016.

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Metabolically Healthy Obesity A subgroup of adults do not experience the cardio-metabolic effects of excessive body fat. This appears to be strongly related to body fat distribution and an increased adipose tissue storage capacity, and to physical activity and cardiorespiratory fitness.[17] Metabolically healthy obesity (MHO) does not yet have a precise medical definition, but prevalence estimates range from 16 to 35 percent. MHO is more prevalent in women than men and decreases with age, with about 50 percent of those with MHO developing metabolic dysfunction in 10 years.[18] MHO is characterized by lower ectopic fat (visceral and liver), higher leg fat, expandability of subcutaneous adipose tissue, preserved insulin sensitivity, and better cardiorespiratory fitness. Transition to from MHO to metabolically unhealthy obesity (MUO) occurs; as does shift from MUH to MHO. Because many conditions are related to obesity (Table 17.2), adults with MHO should be considered for weight loss intervention.

Screening and Assessment

BMI for Classification of Obesity and Associated Risks Body mass index (BMI) is widely used to screen for obesity because it is significantly correlated with total body fat and numerous diseases, and is easy to implement. BMI, calculated from height and weight, is used internationally for classifying overweight and obesity.[19] Overweight in adults is defined by a BMI of 25.0–29.9 and obesity by a BMI of 30 or greater. A BMI of 30 is roughly equivalent to being 30 or more pounds overweight for a 5-ft, 4-in. person. Although BMI approximates body fat for most healthy individuals, there are exceptions:

- Athletes or others with greater-than-average percentages of muscle mass
- Individuals with dense, large bones
- Individuals who are dehydrated, overhydrated, or prone to edema
- Sedentary or disabled individuals with atrophied muscles and increased fat deposits (sarcopenic obesity)

Clinically, obesity is further classified as I, II, and III using BMI (Table 17.3). Severe obesity (also called morbid obesity because of its high correlation with premature death), defined as a BMI of 40 or more, is a dangerous condition that places the person at extremely high risk for cardiovascular and other diseases as well as physical disability and severely impaired quality of life.



New Africa/Shutterstock.com

Photo 17.1 Central adiposity assessed by waist circumference.

Waist Circumference for Central Adiposity The distribution of body fat is a more important indicator of health risk than weight or BMI.[16] Body fat, or adipose tissue, is stored in three compartments: subcutaneous fat layered underneath the skin and buttock and thighs; visceral or intra-abdominal fat packed between internal organs; and ectopic fat stored in the liver, pancreas, heart, and skeletal muscles. Visceral fat, recognized as a potbelly or apple shape (Photo 17.1), and known clinically as *central adiposity,* is highly correlated with metabolic abnormalities and chronic diseases. Waist circumference (WC) is used to assess central adiposity and it allows further stratification of risk beyond BMI. To assess WC, place a tape measure around the abdomen just above the hip bone, level with the navel and parallel to the floor. The tape should be snug but not compressing the skin. Measure after exhaling.[20] The measurement is compared to ethnic-specific values, shown in Table 17.3, for males

Table 17.3 Classification of overweight and obesity by BMI and waist circumference values associated with high risk

	BMI (kg/m²)	Who Obesity Class	Waist Circumference (cm)		
			County/Ethnic Group	Male	Female
Underweight	<18.5		Canada and United States	≥102	≥88
Normal	18.5–24.9		European	≥94	≥80
Overweight	25.0–29.9		Sub-Saharan Africans	≥94	≥80
Obesity	30.0–34.9 35.0–39.9	I II	Eastern Middle East, Mediterranean Ethnic South and Central American	≥94 ≥90	≥80 ≥80
Severe Obesity	≥40	III	Chinese Japanese	≥85 ≥85	≥80 ≥90

Source: Adapted from AACE/ACE Clinical Practice Guidelines for Medical of Patient with Obesity, 2016.

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and females. WC is important in the assessment of obesity because increased central adiposity is associated with higher risk even in a person with normal BMI, and the threshold for risk varies across racial and ethnic groups.[21] Another indicator gaining attention is the waist-to-height ratio (WHtR). In recent studies, the WHtR was found to be the best predictor of both whole-body fat percentage and visceral adipose tissue mass in both men and women. A cut-point value of >0.59 identifies individuals who are at increased health risk and should be advised to "take action" based on the association of central adiposity with negative health outcomes.[22]

Weight Change Change in weight is a practical indicator used in screening for excessive accumulation of adipose tissue and its associated risks, and for assessing progress during and following weight management intervention. A simple metric for screening is weight change since young adulthood. A modest amount of weight gain (<5 kg) is significantly associated with increased risk and earlier onset of chronic disease and 11–19 kg gain is associated with a twofold increase in risk.[23] Weight change, expressed as a percent reduction from initial body weight at the start of weight management intervention, is a primary indicator for assessment of progress and weight maintenance over time, and is strongly related to disease risk.[2]

Methods for Body Composition Assessment Dual energy x-ray absorptiometry (DXA) and bioelectrical impedance are used for body composition analysis in normal-weight and overweight/obese individuals. These methods measure lean body mass and fat mass. DXA provides the most accurate estimate of central adiposity and cardio-metabolic disease risk, but because of cost and practicality it is used primarily in research settings.[24] Devices based on multifrequency bioelectrical impedance analysis (MF-BIA) are cheaper and portable; and when used according to specific protocols, they can be employed in various settings to reliably measure body composition.[25] All methods require training and adherence to measurement protocols for accuracy.[20,25]

Nutrition Assessment

After the need for weight management is identified, a comprehensive assessment is used to understand the individual's experience with overweight, current eating and physical-activity patterns, psychosocial and medical factors, and their motivation and readiness to change, and goals. Table 17.4 outlines possible factors to consider during an assessment for weight management. A patient-centered interview approach allows the client's priorities and perceptions to be expressed and provides information for jointly planning appropriate goals and treatment strategies.[26]

Motivation Several factors contribute to understanding the client's motivation to engage in a weight-loss program: reasons and motivation for weight reduction, previous weight-loss attempts, the patient's understanding of causes of obesity and how obesity contributes to several diseases, existing comorbidities, attitude toward physical activity, capacity to engage in physical activity, time available for weight-loss intervention, and financial considerations.[21,26] Patient's nutrition knowledge, food access, food selection, and functional capacity to prepare food and engage in physical activity are all important for individualized treatment planning.[27,28]

Intervention in Obesity and Overweight

The good news is that relatively small amounts of weight loss (5–10 percent of baseline body weight) are associated with clinically meaningful changes in obesity-related metabolic risks which can reduce or prevent the health conditions associated with obesity.[2,13,21,28] Because of this, the U.S. Preventive Services Task Force recommends that all patients with a BMI ≥30 should be referred for comprehensive weight management, specifically intensive, multicomponent behavorial intervention.[29] Weight reduction is recommended even for those who are mildly overweight (BMI 25–29) when an obesity-related complication is present.[2] The national guidelines for treatment of overweight and obesity use BMI, waist circumference, and presence of obesity-related risks and complications and patient motivation to prioritize individuals for treatment.[2,28,29]

Comprehensive Weight Management Program

An intensive, multicomponent weight management program is needed for successful weight loss, including diet, physical activity, and behavior therapy.[2,19,27-29] Many options exist for delivery of weight management programs, ranging from online programs to community-based programs at the YMCA, to clinic-based medical nutrition therapy provided by registered dietitian nutritionists.

Men and women have different preferences for type of program, delivery options, and outcome goals.[27,30-32] A successful weight-loss plan is tailored to the individual and includes an eating plan that reduces caloric intake relative to calories burned, provides for nutrient needs at a safe level, incorporates physical activity to preserve muscle mass, and is compatible with the individual's lifestyle. In addition to behavioral modification to alter eating and physical-activity patterns, pharmacotherapy can be used to support weight loss. Bariatric surgery is reserved for patients with high-risk comorbid conditions.

Weight-Loss Goals

Goals of weight management are to (1) prevent further weight gain, (2) reduce body weight, (3) maintain a lower body weight for the long term, and (4) prevent or reduce complications. Accomplishing this requires sustainable lifestyle changes.

A moderate rate of weight loss of ½ to 1 lb per week is recommended, but accelerated weight loss of up to 2 lb per week can also be used and may provide positive

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Table 17.4 Nutrition assessment of adults with overweight or obesity and obesity-related diseases and conditions

Anthropometrics
• Height, weight, BMI, waist circumference, waist–height ratio
Food and Nutrition History
• Weight history: age of onset of overweight, highest/lowest adult weights, patterns of weight gain and loss, environmental triggers to weight gain, triggers to excessive or disordered eating
• Dieting experience: number and types of diets, weight-loss medications, success of previous efforts
• Current eating patterns: meal and snack patterns (skipped meals, largest meal, snacks/grazing), timing of eating
• Eating location and environment: meals eaten out (cafeteria, fast food, restaurant, carry lunch), family meals, television on at mealtime
• Types and amounts of food typically eaten: 24-hour recall or food frequency, food preferences, ethnic foods, cultural practices
• Nutritional intake: assessment of reported intake for energy and adequacy of key nutrients
• Total caloric intake
• Type and amount of fat (saturated, mono saturated, polyunsaturated, *trans* fats, omega-3 fatty acid)
• Sources of key nutrients: fruits and vegetables (vitamins A and C, antioxidants and phytochemicals, potassium, fiber), bread and grains (fiber, B vitamins, iron, folic acid), milk and dairy (calcium, vitamin D), fish, meat, beans, nuts (protein, iron, omega-3 fatty acid)
• Energy-dense foods (bakery goods, such as cookies, cake, and sweet rolls), chips and crackers, candy, salad dressings and toppings, specialty coffee drinks, alcoholic beverages, fried foods, sugar-sweetened beverages
• Salty foods: salt-shaker use, processed meats, chips and crackers, nuts, convenience foods, restaurant foods
• Supplement use: nutrient-enhanced food or beverage products, vitamin/mineral supplements, herbal supplements
Physical Activity
• Level of activity at work, school, home; leisure-time activities
• Frequency, intensity, and duration of planned exercise beyond routine work and leisure time activities
Laboratory
• Lipid profile: total serum cholesterol, HDL, LDL, triglycerides
• Glucose: random or fasting glucose, hemoglobin A1c, glucose tolerance test
Medical and Health History
• Obesity severity, extent of physical limitations, impact on activities of daily living
• Potential contributing causes: endocrine, neurological, physical disability, genetics/family history, medications
• Obesity-associated conditions: diabetes, hypertension, cardiovascular diseases, cancer, fatty liver disease, GERD, sleep apnea, osteoarthritis
• Mental health: daily stress level, recent life-changing events (birth, death, marriage, job change or loss, new medical diagnosis), depression, post-traumatic stress disorder, eating disorder (binge eating, bulimia)
• Active medical diagnoses and medication use
Social History
• Occupation, family composition, caretaking responsibilities
• Economic constraints, food insecurity, food/nutrition program participation, access to health-care, coverage for nutrition intervention
Nutrition Knowledge and Attitudes
• Basic understanding about foods and nutrition, guidelines for healthy eating, and recommended serving sizes
• Role of nutrition in patient's diseases or conditions; previous diet instruction or lifestyle-management program
• Level of self-care regarding nutrition: experience in meal planning, food purchasing and preparation
• Confidence in ability
Readiness to Change
• Reasons to lose weight at this time, weight-loss goals
• Stage of change: precontemplation, contemplation, preparation, action, maintenance, relapse
• Support system

reinforcement to continue.[33] A deficit of 3,500 kcal is necessary to lose 1 lb of weight. Thus, a weight loss of ½, 1, or 2 lbs per week requires a calorie deficit of 300, 500, or 1,000 kcal/day, respectively.

Medical Nutrition Therapy for Weight Management

The nutrition prescription for weight loss is an eating plan that is deficient in calories but otherwise meets guidelines for healthy eating. Protein adequacy is important

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for preserving fat free mass and skeletal muscle; and research suggest the benefit of protein intake at two times the RDA (1.6 g/kg/d).[34] A balanced vitamin/mineral supplement may be recommended. Guidelines recommend an evidence-based diet approach that provides a 500 to 700 kcal/d deficit (1,200–1,500 kcal/d for women and 1,500–1,800 kcal/d for men). Strategies for reducing caloric intake include following a menu plan and tracking calories, fat grams, or carbohydrate grams; portion control; and eating four to five meals/snacks, including breakfast. Replacing one or two meals a day with **meal replacements** (liquid meals, meal bars, or packaged meals) is helpful for individuals who have difficulty with portion control. Very-low-energy diets (800 kcal per day) can produce rapid weight loss but should only be used under close medical supervision.[33] Research comparing low-fat and low-carbohydrate diets has shown that either approach can produce weight loss and have positive effects on disease biomarkers, but following a low-carbohydrate plans had some advantage in terms of longer-term weight maintenance.[27] The prescribed diet approach should be determined with the patient, taking into account their preferences, culture, and other condierations.[21,33] Various **intermittent fasting** and **time-restricted eating** regimens, which define periods of not consuming food or drinking calorie-containing beverages followed by ad lib consumption, have gained popularity in self-help and clinical weight management initiatives. The attraction (to users) and the drawback (to clinicians) of these calorie reduction approaches is that they typically do not address food quality or quantity during non-fasting periods. Research studies, with established protocols, have documented positive impacts of intermittent fasting and time-restricted eating on indicators of diabetes and cardiovascular risks.[35,36]

meal replacement A nutritionally balanced beverage, meal bar, or packaged meal used to replace a meal in weight management.

intermittent fasting A regimen of reoccurring periods of fasting followed by periods of unrestricted eating.

time-restricted eating A dietary approach that consolidates all calorie intake to 6- to 12-hour periods during the active phase of the day, without necessarily altering diet quality and quantity.

cognitive behavioral therapy Programs designed to build knowledge, modify beliefs and attitudes, and integrate new behaviors through a combination of skills training and analysis of behavior and thought processes over a period of several weeks. Key features are cognitive restructuring and stimulus control.

Lifestyle Intervention Program for Weight Management

Lifestyle intervention programs, for a 6- to 12-month time period, focused on permanent behavioral change are strongly encouraged. Successful programs developed for weight management, diabetes education, and other lifestyle changes incorporate the principles of **cognitive behavioral therapy.** These programs typically begin with an intensive 12- to 16-week phase to build knowledge, modify beliefs and attitudes, and integrate new behaviors through a combination of skills training and analysis of behavior and thought processes. Key features are helping the client recognize and replace automatic and irrational thoughts and beliefs (cognitive restructuring) and increasing awareness and control of cues associated with eating (stimulus control).[27,37]

A trained interventionist guides the individual or group, reviews progress, and provides reinforcement utilizing 12 components of weight-management programs based on cognitive behavioral therapy:

1. *Realistic goals:* Identify a healthy weight goal and a feasible rate of loss (0.5–1.0 lb/week) and provide the ability to self-monitor progress.
2. *Caloric deficit:* Develop an individualized meal plan with intake adjusted to lose weight gradually.
3. *Meal plan:* Build meal plans around a variety of foods that fit with the patient's lifestyle, food and cultural preferences, and budget; that can be readily obtained; and that can be enjoyed by the entire household.
4. *Skill development:* Provide tools and skills training, including teaching, practicing within sessions, homework, review, and feedback.
5. *Problem-solving techniques:* Assist with development of strategies to anticipate and solve potential weight-management problems.
6. *Self-monitoring and self-management:* Provide tools for keeping food and activity records and build confidence in ability to monitor and adjust.
7. *Cognitive restructuring:* Help client examine thought processes and recognize dysfunctional thinking.
8. *Stress management:* Teach strategies other than eating to deal with stressful situations.
9. *Support system:* Encourage having someone to check in with and receive support.
10. *Regular exercise:* Advise initiation and gradual increase of physical activity, tailored to the patient's ability, aiming for 30–60 minutes most days of the week and including aerobic and muscle-strengthening activities.

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11. *Maintenance:* Make available support for weight loss and for maintenance of the loss.
12. *Long-term effectiveness:* The weight-management plan is built around learning and practicing behaviors that can be maintained for a lifetime. Often follow-up "booster" sessions are offered to support long-term adherence.

Physical Activity for Weight Management

Added physical activity, including reducing sedentary activity at work and home and engaging in a planned physical activity or exercise regimen, contributes to the energy deficit required for weight loss. Additionally, a combination of resistance training and aerobic exercise protects from skeletal muscle loss, enhances reduction of fat mass, and improves conditioning. Thus, physical activity is considered an essential component of weight loss and weight maintenance.[2,21,27,33,38] Ideally, an exercise regimen is tailored to the needs and capabilities (e.g., cardiorespiratory fitness and musculoskeletal problems) and preferences of the individual to optimize adherence. Working with fitness professionals or joining organized programs enhances success for some. Weight management guidelines recommend 200–300 minutes of "high-level" physical activity per week. Continuation of this higher level of physical activity is necessary to maintain weight loss or prevent weight gain.[2]

One study found that 275 minutes per week of physical activity, in combination with a reduction in energy intake, was important in enabling women experiencing overweight to sustain a weight loss of more than 10 percent for 2 years.[39]

The Challenge of Weight Maintenance

After 6 months, the rate of weight loss usually declines and weight plateaus, due in part to a decline in metabolic rate—the body's physiological response to protect against starvation.[7] This metabolic compensation, termed an **energy gap**, varies, but has been estimated at about 8 kcal/lb lost per day.[40] However, even after adjustment for energy balance, other variables such as sitting time, quitting smoking, and, for women, menopause and having a hysterectomy are independently associated with weight regain over a 5-year period.[40] Long-term maintenance of weight loss requires lifelong personal adherence to behaviors that balance calories consumed with energy burned for an aging body that requires fewer calories and in an environment that pushes food and fosters sedentary lifestyles.

A widely held misconception is that most people regain all lost weight and more. Follow-up studies have found that without maintenance intervention, participants typically regain one-third of lost weight in the year following treatment. However, with engagement in maintenance programs, 35 to 60 percent of participants sustain a weight loss of ≥5 percent of initial weight for more than 2 years and over 20 percent are successful at maintaining a 10 percent weight loss for at least 1 year.[27]

Individuals who use more behavioral strategies to support weight loss and maintenance tend to be more successful.[2] These behaviors include consistently controlling caloric intake [through restricted intake of certain types or classes of food (e.g., low carb), limiting fast food, eating all foods but in limited quantities, counting calories, or limiting percentage of daily energy from fat], exercising more often and more strenuously, tracking weight, and eating breakfast.[2,21,33]

Follow-up weight maintenance programs are strongly recommended.[2,21,29,30] National guidelines acknowledge that weight maintenance for many individuals requires ongoing therapy, yet many health plans do not cover this unless the patient has a **comorbidity.** Some health plans employ lifestyle coaches who use telephone and electronic media to assist patients in sustaining behavioral changes and maintaining the health benefits of reduced risk for diseases. Research backs up the effectiveness of this strategy.[30] Smartphone apps and wearable devices for monitoring and managing weight are widely available. These tools are helpful to self-motivated individuals and may contribute to prevention of weight gain. Refer to Case Study 17.1 for a realistic example of weight challenges faced by adults.

Pharmacotherapy for Weight Loss

For some, comorbidities and risk factors warrant addition of anti-obesity medications (AOM) to the comprehensive intervention plan. Research has found that medications combined with lifestyle modification produces slightly greater weight loss than lifestyle modification and placebo.[2,21] They are also prescribed to maintain weight loss. Mechanisms for AOM action target energy intake through appetite suppression and inhibiting fat absorption from the gut. A recently approved drug activates pancreatic cells; and new lines of research are investigating drugs that could impact energy utilization pathway.[41] Numerous over-the-counter and herbal weight-loss preparations offer hope for those seeking help, a few modest effects on weight have been reported, but most have not been tested for efficacy and safety and are not recommended.[42]

energy gap The required change in energy expenditure relative to energy intake necessary to restore energy balance.

comorbidity The presence of one or more diseases or conditions in addition to the primary disease or disorder.

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Case Study 17.1 Maintaining a Healthy Weight

Arlo is 5′11″ tall and weighs 190 lb. He is a single father with two teenage sons. The commute to and from his software development job takes about 90 minutes. He likes his coworkers and the work environment and is happy that his workplace provides a cafeteria so he doesn't have to bring a lunch. He believes it is important for the family to have a "hot meal" every night, but he mostly relies on frozen entrées or take-out to accomplish this. Frequently, the evening meal is from the drive-through window of a fast-food restaurant on the way to his sons' sport events. Arlo is an avid football and basketball fan and spends many hours watching televised games. In his spare time, he is restoring an old car with his sons.

Questions

Assessment

1. Calculate Arlo's current BMI. How would you classify his weight status based on the clinical classifications shown in Table 17.3?
2. What would you consider a healthy BMI and "healthy weight" for Arlo?
3. What lifestyle and dietary factors are related to Arlo's weight status?

Diagnosis

4. What is Arlo's nutrition diagnosis? What modifiable factors cause or contribute to this problem? What evidence do you have for the problem?

Intervention

5. What dietary prescription would you have for Arlo? What goal would you recommend? *Hint:* Calculate a calorie intake level and estimate the number of weeks it would take for Arlo to reach a healthy weight.
6. What interventions would you use to help Arlo reach the goal? What topics and suggestions would you discuss with Arlo?

Monitoring and Evaluation

7. What would you measure later to determine if Arlo was making progress?



Photodisc

Metabolic/Bariatric Surgery

Bariatric surgery is reserved for patients with clinically severe obesity who meet criteria (BMI ≥40 or ≥35 with high risk for obesity-related morbidity or mortality, and generally after other therapy has been tried for 6 or more months without success).[2,21] In such patients, surgery is the most effective therapy for weight management. Weight loss following surgery is rapid in the first 6–12 months and most patients lose 60 percent of excess weight in 3 years.[43] Bariatric surgery has been shown to result in improvement or resolution of obesity-related comorbidities (e.g., lower blood glucose, better lipid profile, lower blood pressure, reduced cardiovascular disease risks, and increased mobility). Thus, it is referred to as "metabolic surgery." Because of the positive metabolic outcomes, bariatric surgery is now being offered to patients with lower BMIs who have type 2 diabetes, hyperlipidemia, and other conditions. Surgical procedures reduce stomach size and restrict intake (sleeve gastrectomy) or produce malabsorption by bypassing a section of the small intestine (Roux-en-Y procedure). Another procedure (intragastric balloon) involves the temporary placement of a balloon in the stomach to restrict intake. Patients considered for bariatric surgery must be highly motivated to adhere to aftercare guidelines to prevent the onset of postoperative complications (nausea, vomiting, dehydration, and dumping syndrome) and prevent long-term nutritional deficiencies.[2,21,43] Patients treated with bariatric surgery are at risk for micronutrient deficiencies and should have ongoing monitoring of serum nutrient levels.[43]

17.2 Cardiovascular Diseases

Cardiovascular diseases (CVDs) are diseases related to the heart and blood vessels and are usually associated with atherosclerosis (stiffening or hardening of the arteries), which is a buildup of plaque in the endothelium of the blood vessel wall. The areas affected include the heart (coronary heart disease, or CHD), the brain (cerebral vascular disease leading to stroke), and blood vessels in

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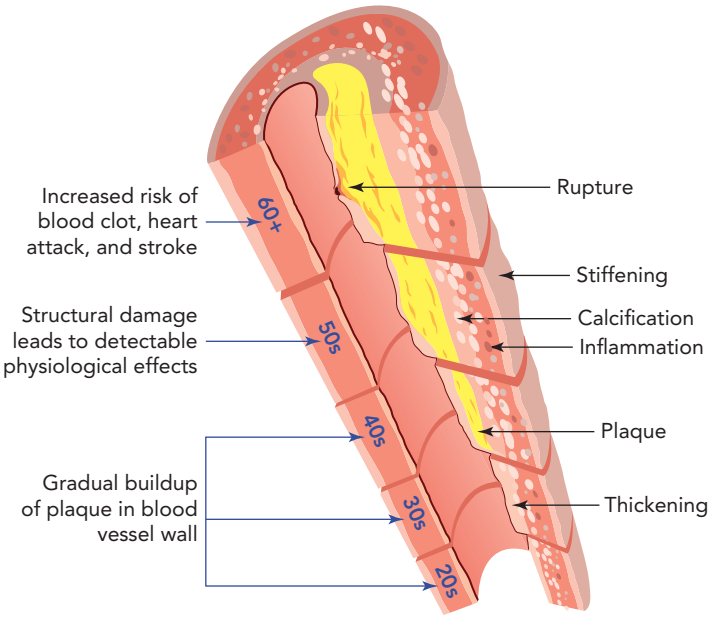


Figure 17.2 Atherosclerotic blood vessel changes during the adult years.

the legs (peripheral arterial disease, or PAD). Atherosclerotic lesions begin to form in childhood and adolescence and gradually develop through the decades (Figure 17.2). Lesions remain asymptomatic until the thickening wall reduces blood flow, leading to **ischemia**, or a lesion ruptures and a blood clot forms, resulting in a heart attack (myocardial infarction) or stroke.

In efforts to reduce CVD mortality and shorten morbidity (period of time suffering with disease), attention has been directed to prevention and the construct of **cardiovascular health (CVH).**[44] A CVH score reflects the composite of seven measurable and modifiable medical and behavioral factors related to CVD, namely: total cholesterol, blood pressure, fasting glucose, BMI, diet, physical activity, and smoking. By tracking CVH (in national surveys such as NHANES and longitudinal and other studies), population trends can be detected and priorities for intervention identified. Giving added attention to preserving a healthy state is aligned with the concept of **primordial prevention**, with the aim of taking action upstream to prevent risk factors from occurring in the first place. As shown in Table 17.5, Healthy People 2030 objectives include indicators that range from cardiovascular *health* to coronary heart disease and stroke *deaths*.[45]

Prevalence of CVD

The prevalence of CVD, including CHD, heart failure, and stroke, among U.S. adults age 20 years and older is 26.1 million. This increases to 126.9 million when hypertension is added.[46] Prevalence statistics are shown in Table 17.6 for race/ethnic and male/female subgroups. Men develop CVD at a younger age, but women, who benefit from the protective effect of estrogen, catch up after menopause. Many people think of CVD as an "old person's" disease, but sclerotic blood vessel changes develop early and become more clinically evident by the thirties; and hyperlipidemia and hypertension are easily measured early biomarkers that are related to the development of these changes.

Around age 45 there is a striking increase in stroke and CHD deaths. Notably, about one-fifth of both coronary heart disease and stroke deaths happen to adults younger than 65 years.[47]

Racial/ethnic and sex differences in risk factors for CVD are linked with earlier disease onset and higher death rates. Moreover, social adversity (defined using the social determinants of health framework) is linked to higher CVD burden, while favorable social conditions have protective effects.[48] Disparities in diet quality compound the disproportionate burden of CVD in disadvantaged and underserved populations.[49] These disparities are being investigated using new research methods ranging from genetic studies to ethnographic research.

ischemia Inadequate blood supply to a local area due to partial or complete blockage of a blood vessel.

cardiovascular health score (CVH) A composite number based on seven measurable and modifiable medical and behavioral factors related to CVD: total cholesterol, blood pressure, fasting glucose, BMI, diet, physical activity, and smoking.

primordial prevention Actions to prevent development of a disease risk factor through very early intervention including pregnancy, infancy, childhood, and young adulthood.

Table 17.5 Selected Healthy People 2030 objectives related to cardiovascular disease

Maintain Healthy State	Identify Those at Risk	Reduce Risk Factors	Delay or Prevent Death
• Improve cardiovascular heath score in adults • Reduce the mean total blood cholesterol level of adults	• Increase the proportion of adults who have had their risk for developing atherosclerotic cardiovascular disease (ACVD) assessed	• Increase the treatment of blood cholesterol among eligible adults • Increase the proportion of adults with hypertension whose blood pressure is under control	• Reduce coronary heart disease deaths • Reduce stroke deaths

Source: Adapted from Healthy People 2030. Available at http://healthypeople.gov/2030.

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Table 17.6 Cardiovascular disease and risk indicators by race/ethnicity and sex

	LCL-C > 130		High Blood Pressure		CVD Prevalence (coronary heart disease, heart failure, stroke)		Percent of All Deaths from Heart Disease	
	Male	Female	Male	Female	Male	Female	Male	Female
White	26.0	28.6	51.1	40.5	10.4	7.8	24.9	22.5
Black	29.3	24.3	58.3	57.6	11.0	11.5	24.9	23.1
Hispanic	29.4	26.3	50.6	40.8	8.7	8.1	20.6	19.9
Asian	33.4	26.9	51.0	42.1	6.8	4.2	22.9	19.9
Native American							19.4	17.0

Sources: American Heart Association. Heart Disease and Stroke Statistic–2022 Update; CDC Heart Disease Facts. cdc.gov/heartdisease/facts.htm, accessed February 18, 2022.

Etiology of Atherosclerosis

Atherosclerosis begins when fatty deposits become part of tissues that form over injured arterial wall cells. Fibrous plaques (containing fats, cholesterol, triglycerides, collagen, muscle, white blood cells, and other cells and metabolites) form. These lesions gradually become calcified and blood vessels stiffen, increasing the extent of atherosclerosis.[50] Chronic vascular inflammation makes arteries susceptible to plaque development.[51] High blood levels of homocysteine, abnormal blood clotting factors, central adiposity, elevated blood glucose and insulin levels, and other conditions also influence the development of atherosclerosis.[51] The progression of atherosclerosis can be slowed, neutralized, or partially reversed by dietary and lifestyle modifications.[52]

Physiological Effects of Atherosclerosis

The buildup of lesions and plaque inside the blood vessels (atherosclerosis) reduces blood flow and vessels lose flexibility. To compensate for this, the heart has to work harder to pump blood through this narrower space to reach all parts of the body, leading to higher blood pressure levels. Atherosclerosis decreases blood circulation to the heart, resulting in decline in organ function. CHD can present as decreased energy and shortness of breath after exertion or chest pain (angina) and death from a heart attack. Plaque in carotid and cranial arteries, complicated by hypertension, leads to stroke, with transient or permanent changes in mental and physical functioning. Poor circulation to the extremities due to PAD causes pain and limits physical activity. The progression of these cardiovascular diseases significantly interferes with activities of daily living, reduces quality of life, and can result in early death.

atherosclerosis A disease of the arterial blood vessels (arteries) in which the walls of the blood vessels become thickened and hardened by cholesterol and calcium-containing plaque.

dyslipidemia Abnormal blood levels of cholesterol and/or triglycerides resulting from altered lipid metabolism.

dysglycemia An abnormality in blood glucose stability.

Risk Factors for CVD

The risk factors for the various CVD have been known and targeted for intervention for many years, and they include **dyslipidemia** [elevated low-density lipoprotein (LDL) cholesterol, elevated very low density lipoprotein (VLDL) cholesterol (carrier of triglycerides), and low level of high-density lipoprotein (HDL) cholesterol]; high blood pressure; central adiposity; **dysglycemia**; and the lifestyle factors of diet, physical inactivity, and smoking. Genetics, evidenced through a family history of CVD and inherited types of dyslipidemias, and older age are also risk factors.[53]

HDL and LDL have been referred to as "good" cholesterol and "bad" cholesterol, respectively. HDL scavenges excess LDL cholesterol and transports it to the liver for recycling and removal from the body. LDL delivers cholesterol to cells for storage and synthesis of hormones; however, different subtypes of LDL ("large-fluffy" vs. "small-dense") behave differently. Small, dense LDL particles contain more apolipoprotein B that makes it more available for binding to the lining of arteries and entry into the endothelium and therefore more atherogenic.[54] Risk for development and progression of CVD is interconnected with obesity, diabetes, infection, and inflammation. Risk is also affected by menopause, which is associated with changes in HDL function and effectiveness.[55]

Screening and Assessment of CVD

Screening should occur about every 5 years beginning at age 20. Conventional risk factors noted previously have been incorporated into screening tools to determine lifetime and 10-year risk for having a major adverse cardiac event (e.g., heart attack).[53] (Go to www.cvriskcalculator.com to calculate your risk.) Race/ethnicity is also considered because of known differences in susceptibility to risk factors by some populations. A recent addition to screening procedures for asymptomatic patients is a computerized tomography (CT) scan that measures calcium deposits in arteries and produces a coronary artery calcium (CAC) score. It can measure coronary artery disease before signs and symptoms occur. The CAC score provides a substantial increase in the accuracy of CVD risk stratification.[56] Levels of the factors listed in Table 17.7 are used

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Table 17.7 Risk factors and criteria for CVD and CHD

Risk Factor	Criteria for Risk
Dyslipidemia	
Total cholesterol (TC), mg/dL	Desirable: <200 Borderline high: 200–239 High: ≥240
Low-density lipoprotein cholesterol (LDL-C), mg/dL	Desirable: <100 Borderline high: 130–159 High: 160–189 Very high: ≥190
Non-high-density lipoprotein cholesterol (Non-HDL-C), mg/dL	Desirable: <130 Borderline high: 160–189 High: 190–219 Very high: ≥220
High-density lipoprotein cholesterol (HDL-C), mg/dL	Low: <40 High: ≥60 (high HDL compensates for other risk factor)
Triglycerides (TG), mg/dL	Desirable: <150 Borderline high: 150–199 High: 200–499 Very high: ≥500
Other Clinical Risk Factors	
Fasting blood glucose, mg/dL Hemoglobin A1c	>110 >6.4
Hypertension	Stage 1: Blood pressure 130–139/80–89 mmHg Stage 2: Blood pressure ≥140/90 mmHg
Overweight/Obesity	BMI >25 (overweight) or >30 (obese)
Clinical conditions	Clinical atherosclerotic disease, diabetes, chronic kidney disease, metabolic syndrome
Comorbidity	HIV/AIDS
Older age and sex	Men ≥45 years Women ≥55 years
Family history of premature CHD	Parent or sibling with CHD
Lifestyle Factors	
Cigarette smoking/tobacco use	Current smoker
Food intake patterns	Few vegetables, fruits, and whole grains High saturated fats and *trans*-fatty acid intake Infrequent intake of fish (low omega-3 fatty acid intake)
Sedentary lifestyle Lack of physical activity	Less than 30 minutes of moderate physical activity on most days of the week (<150 minutes a week)
Emotional stress	Unresolved emotional stress Hostility, angry personality
Emerging Risk Factors	
Elevated levels of high-sensitivity C-reactive protein (indicator of inflammation), mg/L	Lower risk: <2.0 Average risk: 1.0 to 3.0 Very high risk: >7.0
Plasma apolipoprotein B (Apo B), mg/dL	If moderate to high risk: <90 is desirable If very high risk: <80 is desirable
Low-density lipoprotein particles (LDL-P) number	Desirable: <1,000; High: >1,600
Coronary artery calcium (CAC) score	Risk: ≥300 Agatston units

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to determine level of risk, target interventions, and determine the aggressiveness of therapy. The table includes well-established indicators, and additional emerging biomarkers that are associated with CVD but are not routinely used as screening factors.[53,56-58]

Nutrition Assessment

People identified at high risk should be referred to a registered dietitian nutritionist for a nutrition assessment (Table 17.4) and individualized intervention.[52,53,59-61] Key assessment components include

- Food and nutrition history to determine usual intake, especially amount and type of fat, fruits and vegetables, bread and grains, meat, fish, and dairy foods; meal and snack patterns; and supplement use
- Nutrition knowledge of healthy-eating recommendations and relationship of food choices to CVD risk, and attitudes about food choices and change
- Physical activity
- Anthropometric measurements of weight, height, BMI, and waist circumference and weight gain history
- Laboratory values for lipid profile and blood glucose
- Medical and social history to clarify other health and lifestyle factors that impact nutritional status, food choice and access, and motivation and ability to initiate and maintain lifestyle changes

Nutrition Interventions for CVD

Ideally, nutrition intervention for CVD should begin early in life to prevent or delay the development of atherosclerosis. Population-oriented messages and dietary guidance are approaches to primary prevention. Within the health-care system, implementation of 10 dietary strategies (refer to Sikand and Severson[59]), along with team-based care, are recommended to advance CVD risk reduction.[59,61,62] When risk factors develop or CVD is diagnosed, intervention shifts to the individual level with patient-centered medical nutrition therapy and **therapeutic lifestyle change** interventions.

therapeutic lifestyle change A higher-intensity intervention approach with focus on sustained behavior changes to reduce risk and slow disease progression among high-risk individuals. Often includes individual, group, and virtual components delivered through clinic or community organizations over a period of months.

cardio-protective diet A diet that emphasizes plant foods (vegetables, fruits, grains, especially whole grains, and legumes), appropriate fats, and fish, along with smaller amounts of lean meat and dairy.

pharmacotherapy Treatment of disease through the use of drugs.

Primary Prevention Eating for cardiometabolic health is not on the top of the agenda for many young adults, but eating habits during those years influence the development of atherosclerosis and risk for CHD and stroke. All young and middle-aged adults, with risk factors or not, should follow the principles of a **cardio-protective diet** that emphasizes plant foods (vegetables, fruits, and whole grains), appropriate fats (replacing saturated fat with nontropical polyunsaturated and monounsaturated fats), fish, poultry, legumes and nuts, and low-fat dairy.[13] The dietary recommendations presented in Chapter 16 and the DASH, Mediterranean and vegetarian diets represent cardio-protective patterns of eating.

Over the years, the American Heart Association (AHA) and other medical associations and health organizations have promulgated prevention recommendations and guidelines to modify diet, physical activity, and tobacco exposure to reduce risk for CVD across the population.[63–65] Part of this involves recommendations for changes within systems that influence the foods people eat and the physical activities they are able to include in their daily routine.[63] Table 17.8 lists evidence-based, population-level recommendations for changes that can be made by big industries such as the media and the food industry, and for changes at worksites that impact what adults choose to eat.

Primary prevention at the clinic level involves identifying and addressing risk factors as they emerge. Using the 5A Model (assess, advise, agree, assist, and arrange), health-care providers can routinely discuss, encourage, and reinforce specific actions tailored to the individual's needs, resources, and abilities.[64] This low-intensity approach to behavioral counseling can be effective especially among motivated individuals.[59,62,64] The aim is to prevent subclinical signs and symptoms from developing into overt acute and chronic CVD.

Management of High Risk A more intensive intervention called therapeutic lifestyle change, with ongoing behavioral counseling and follow-up by health-care providers, is recommended for individuals identified at high risk, especially those with obesity and metabolic syndrome (discussed in the next section) and those with CVD diagnoses.[52,60,66] Diet and lifestyle change is the cornerstone of therapy and is recommended even when **pharmacotherapy** (lipid-lowering medication) is implemented. In medical nutrition therapy, the registered dietitian nutritionist tailors behavioral change and outcome goals to each individual's situation. Specific dietary recommendations are advised based the individual's baseline dietary intake, laboratory values, weight status, blood pressure, medical history, as well as food preferences, food

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Table 17.8 Evidence-based population approaches for improving diet

Media and education	Sustained, focused media and education campaigns for increasing consumption of specific healthful foods and decreasing consumption of specific less healthful foods or beverages
Labeling and information	Mandate nutrition information panels or front-of-package labels or icons as a means to influence industry behaviors and product formulations
Economic incentives	Subsidy strategies to lower prices of more healthful food and beverages Tax strategies to increase prices of less healthful food and beverages Changes in both agriculture subsidies and related policies to create an infrastructure that facilitates production, transportation, and marketing of healthier foods, sustained over several decades
Workplaces	Comprehensive worksite wellness programs with nutrition, physical activity, and tobacco cessation/prevention components Increased availability of healthier food/beverage options and/or strong standards for foods and beverages served, in combination with cafeteria and vending machine prompts, labels, or icons to make healthier choices
Local environment	Increase availability of supermarkets near homes

Source: Adapted from Population Approaches to Improve Diet, Physical Activity, and Smoking Habits: A Scientific Statement of the American Heart Association.

access, and resources. Table 17.9 outlines typical dietary modification to support weight loss, blood cholesterol, and blood pressure goals. After years of recommending low-fat diets, focus has been redirected to moderate fat intake (30–35 percent of calories) with emphasis on the type of fat: reducing saturated fat to less than 7 percent of calories and replacing it with polyunsaturated fat (from fish and vegetable oils), monosaturated fat (olive oil), and avoiding *trans* fats.[13,59] Additionally, consumption of plant stanols/sterols and additional viscous fiber are encouraged because of their known positive effect on blood cholesterol.[67,68]

More intensive intervention is important to support the individual in making lifestyle changes to reduce risk factors and halt or reverse atherosclerotic processes and prevent a coronary event (heart attack) or death. The intensive approach of therapeutic lifestyle change, which often includes individual, group, and virtual components delivered through clinic or community organizations over a period of months utilizes the strategies discussed previously in the cognitive behavior change section.

Stanols/Sterols Plant stanol and sterol esters are an essential component of plant cell membranes that resembles the chemical structure of animal cholesterol. When eaten, they block particles responsible for cholesterol transport, which results in less cholesterol absorption. Regular consumption of 2–3 g per day (divided into two servings) with meals is associated with a 9–12 percent reduction in LDL.[67] Sources include wheat germ and bran, peanuts and almonds, and vegetable oils. However, more concentrated sources are food products formulated with stanol and sterol esters, such as margarines, salad

Table 17.9 Diet recommendations to reduce LDL-C, blood pressure, and obesity

1. **Dietary Pattern** Consume a dietary pattern that emphasizes intake of vegetables, fruits, and whole grains; includes low-fat dairy products, poultry, fish, legumes, nontropical vegetable oils, and nuts; and limits intake of sweets, sugar-sweetened beverages, and red meats.
   a. Adapt this dietary pattern to appropriate calorie requirements, personal and cultural food preferences, and nutrition therapy for other medical conditions (including diabetes mellitus).
   b. Achieve this pattern by following plans such as the DASH or Mediterranean dietary pattern
2. **Type of Fat** Reduce percent of calories from saturated fat; aim for <7% of calories from saturated fat. Replace saturated fat with unsaturated fat, preferably polyunsaturated fat, not carbohydrates.
3. **Sodium** For those who could benefit from blood pressure reduction (two-thirds of adult population). Lower sodium intake to 2,400 mg or preferably 1,500 mg per day; or reduce by at least 1,000 mg per day.
4. **Calorie Restriction** For those who need to lose weight based on BMI or WC (two-thirds of population) 1,200–1,500 kcal per day women, 1,500–1,800 kcal per day men (adjusted for current body weight), or 500–750 kcal per day energy deficit
   a. Prescribe evidence-based diet that restricts certain food types; choose based on patient preference and health status
   b. Aim for 3–5% weight loss for clinical outcomes, but aim for greater loss to get greater clinical changes and avoid need for medications
   c. Refer to nutrition professional for counseling and/or recommend comprehensive lifestyle program of at least 6 months to assist in adhering to diet and increasing physical activity.

Sources: Adapted from 2013 AHA/ACC Guideline on Lifestyle Management to Reduce Cardiovascular Risk: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines; Report of the 2020–2025 Dietary Guidelines Advisory Committee.

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dressings, beverages, and bars, and supplements available as soft-gel capsules. Routine consumption of stanols and sterols as part of a heart healthy diet is a feasible preventive approach that reduces blood levels of LDL and thereby minimizes exposure to its atherogenic effects.

Viscous Fiber Viscous fiber is the "sticky" type of soluble fiber found in oats, barley, and flax, psyllium-enriched cereals, legumes (beans and lentils), some fruits (apples, mangoes, plums, kiwi, pears, berries, peaches, citrus fruits, and dried apricots, prunes, and figs), and certain vegetables (such as okra and eggplant). Viscous fiber is responsible for the fiber-related physiological effects of decreased LDL. Viscous fiber holds water in the gut, forming a thick gel that reduces absorption of cholesterol-rich bile acids and carries them out of the body. When this happens, the liver shifts from producing cholesterol that ends up in the blood to producing bile acids that are necessary for digestion. In addition, fermentation of fiber by colonic bacteria inhibits fat absorption and cholesterol transport and synthesis.[68] Eating 5–10 g of viscous fiber (1½ cups of cooked oatmeal provides 3 g) a day has been shown to reduce LDL by 10–15 percent.[69] Studies of other types of dietary fiber have found cardio-protective effects, including association with C-reactive protein, overall inflammation, and CVD risk.[68]

Pharmacotherapy of CVD

Lipid-lowering medications are prescribed when LDL is >190 mg/dL and at lower levels (70–189 mg/dL) if the individual has an increased 10-year risk score or diabetes.[60] Primarily two types of drugs are used to lower blood cholesterol levels. Statins are widely used and work by blocking the enzyme (HMG-CoA) responsible for making cholesterol in the liver resulting in LDL cholesterol reductions of 30 to <50 percent. They also stabilize plaques, making them less prone to rupture and form clots that can block arteries. Statins also reduce arterial inflammation, which contributes to atherosclerosis. Other types of drugs inhibit intestinal absorption of cholesterol. Lowered blood cholesterol results in reduced formation of new plaques and reduced size of existing plaques lining arterial walls.[70]

17.3 Metabolic Syndrome

Metabolic syndrome designates a cluster of altered metabolic conditions that come together in a single individual, and place that person at high risk for coronary artery disease, stroke, and type 2 diabetes. The metabolic conditions include abdominal obesity indicated by large waist circumference, elevated blood pressure, insulin resistance indicated by elevated fasting glucose, and dyslipidemia indicated by elevated triglycerides and low HDL cholesterol.[71] The diagnosis of metabolic syndrome is made when an individual has any three of these five indicators. Cut points used in diagnosing metabolic syndrome are included in Table 17.10.

Table 17.10 Criteria for diagnosis of metabolic syndrome

Large waist circumference	Men: ≥40 in. (102 cm) Women: ≥35 in. (88 cm)
Elevated blood triglyceride	Risk: >150 mg/dL
Low high-density lipoprotein cholesterol	Men: <40 mg/dL Women: <50 mg/dL
Elevated blood pressure	≥130 (systolic) or >85 (diastolic) mmHg
Elevated fasting blood glucose	≥100 mg/dL

Source: International harmonized definition of metabolic syndrome: Alberti, K. G., et al. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. *Circulation*. 2009; 120:1640–1645.

Prevalence of Metabolic Syndrome

Metabolic syndrome affects about a third of U.S. adults.[46] Prevalence estimates using NHANES and other study data indicate sharp increases with age—affecting about 19.3, 37.7, and 54.9 percent, of those aged 20–39, 40–60, and >60 years, respectively.[46] The metabolic condition showing the greatest rate of increase over the years was waist circumference for both men and women. Among non-obese individuals, the prevalence of metabolic syndrome has been stable at about 16 percent.[72] However, a recent longitudinal study found the highest mortality rate among the subgroup of normal weight adults with metabolic syndrome.[73]

The prevalence of metabolic syndrome varies by ethnicity and sex, even after accounting for a person's BMI, age, socioeconomic status, and other factors. Mexican American men and women had the highest rates in the 1990s, but White men and Black women are catching up.[72] North American and Alaskan Native subpopulations have a wide range of metabolic syndrome rates that parallel the subgroups' rates of diabetes. The Strong Heart Study found a prevalence of 55 percent among Native American adults (aged 45 to 75 years), compared to 34.7 percent for the general population at that time (2011–2016), with higher rates among women.[74] Black people with very high BMIs and very high levels of insulin resistance can have very low levels of triglycerides, even though they have a significantly higher prevalence of cardiovascular disease and diabetes compared to White people.[75] The diagnosis criteria that relies on triglyceride levels as a marker for metabolic syndrome may result in underdiagnoses in Black people. Asian Americans, especially from South Asia, can develop metabolic syndrome with only moderate excess in abdominal fat.[23] Thus, Black and Asian adults could be at risk for metabolic syndrome with only two metabolic risk factors.

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Etiology of Metabolic Syndrome

The underlying cause of metabolic syndrome is not entirely clear, but it is thought to result from central adiposity and insulin resistance. Insulin resistance refers to the diminished ability of cells to respond to the action of insulin in promoting the transport of glucose from blood into muscles and other tissues. To compensate, the pancreas produces more insulin, resulting in **hyperinsulinemia**. A sedentary lifestyle and a pro-inflammatory, atherogenic diet (high calories, total fat and saturated fat, and low in whole grains, vegetables, and fruits) contribute to insulin resistance. Progressive weight gain and high body fat (especially central obesity), inflammation, existing cancer, and HIV also increase risk.[71,76]

As is true with many medical conditions, genetics and the environment both play important roles in the development of the metabolic syndrome. Genetic factors influence each individual component of the syndrome, and the syndrome itself. A family history that includes type 2 diabetes, hypertension, and early heart disease greatly increases the chance that an individual will develop the metabolic syndrome.[71,76] Moreover, it should be recognized that socioeconomic status, level of education, and geographic location are significant social determinants of health that are associated with metabolic syndrome and its outcomes. Underserved and isolated population groups, such as Native American and Alaska Native people, experience the challenges and consequences of limited access to preventative health and treatment services.[74]

Effects of Metabolic Syndrome

The hyperinsulinemic state related to insulin insensitivity is considered a prediabetic condition, but it is also recognized as a major risk factor for the development of early atherosclerotic cardiovascular disease.[71,76] The presence of metabolic syndrome substantially increases the risk of developing type 2 diabetes, heart disease, and stroke.[46] Metabolic syndrome is also associated with fat accumulation in the liver (fatty liver disease or steatohepatitis), chronic kidney disease, obstructive sleep apnea, sexual/reproductive dysfunction (erectile dysfunction in males and polycystic ovary syndrome in women), and cognitive decline and dementia in the elderly, as well as a general proinflammatory and prothrombotic state.[76]

Screening and Assessment

Waist circumference is a simple, low-cost method that can be used to screen for metabolic syndrome in community or clinic settings and identify those who should be referred for laboratory tests.[71] A fasting lipid profile providing LDL cholesterol, HDL cholesterol, and triglyceride levels, and fasting blood glucose, along with blood pressure, are necessary for diagnosis and provide baseline measures to track changes over time.[71,75] Screening for metabolic syndrome is recommended beginning at age 45 for asymptomatic adults or earlier for individuals who are overweight and have one additional risk factor, such as smoking or physical inactivity. With identification, earlier treatment can be initiated to minimize the effects noted previously, and with lifestyle intervention, metabolic syndrome can be reversed for some individuals.[77]

Insulin resistance, a hallmark of metabolic syndrome and type 2 diabetes, can present with phenotypic manifestations (physical signs). These are hyperpigmentation of the skin at the back of the neck (acanthosis nigricans),[78] "buffalo hump" (fat accumulation at the base of the neck), and double chin.[79] These signs suggest high risk and should signal further assessment. Case Study 17.2 presents a somewhat typical picture of metabolic syndrome.

Nutrition Interventions for Metabolic Syndrome

The goal of clinical management of metabolic syndrome is to reduce the risk of atherosclerotic diseases and progression to diabetes. Intervention is directed to the problem identified: for central adiposity, reduce weight and fat mass; for dyslipidemia, achieve an optimal lipid profile; for hypertension, normalize blood pressure; and for elevated glucose, reduce fasting blood glucose and increase insulin sensitivity.[71,76,77] The first-line therapy, guided by the registered dietitian nutritionist or other health-care provider, is diet and lifestyle modification to adopt healthy eating, increase physical activity, and reduce weight.[77] Intervention should be culturally relevant, and personalized to the individual's situation. Refer to the Intervention sections of Overweight and Obesity, CVD, and Diabetes Mellitus for details. Exercise has beneficial effects on blood pressure, cholesterol levels, and insulin sensitivity, even if weight loss is not achieved.[77] If a period of lifestyle intervention does not reduce risk factors, or the individual is in a high-risk category, medications to treat the dyslipidemia, hypertension, elevated blood glucose, and/or insulin resistance are added.[71,76] Bariatric surgery is also considered for those with a BMI >35.

17.4 Diabetes Mellitus

Diabetes is a chronic disease associated with abnormally high levels of glucose in the blood (**hyperglycemia**). The hyperglycemia is due to one of two mechanisms: minimal

hyperinsulinemia A state of excess levels of insulin circulating in the blood. It is common among persons with metabolic syndrome and type 2 diabetes and is caused by the pancreas trying to compensate for insulin resistance of cells.

hyperglycemia Abnormally high levels of glucose in the blood.

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Case Study 17.2 Managing Metabolic Syndrome in Adults: Dante Goes Dancing

Dante is 59 years old, semiretired, and lives with his wife in a midtown apartment complex. Dante was diagnosed with metabolic syndrome 10 years ago, and he has since gained 15 lb. He attributes his weight gain to lazy afternoons in front of the television and frequent suppers at a local buffet restaurant. Though he plans to take his wife ballroom dancing on the evening of their wedding anniversary, Dante fears he will be out of shape and uncomfortable in the tight confines of his old suit. His wife suggests that the couple speak with a health professional regarding the management of his metabolic syndrome before attempting to lose weight. The following information is obtained at a recent medical follow-up.

Height: 5′9″
BMI: 32 kg/m2
Waist circumference: 42″
Weight history (lb):
  Current: 225
  Highest: 225
  At age 20: 175
Healthy body weight:
  155 to 165

TCHOL: 218 mg/dL
HDL: 33 mg/dL
LDL: 154 mg/dL
TRIG: 155 mg/dL
FBS: 125 mg/dL
TSH: Normal
HgbA1c: 7.1%
Blood pressure:
  130/90

Questions

1. From the information gathered at his medical visit, how well do you think Dante is managing his metabolic syndrome? Why?
2. What are the desired goals for metabolic syndrome factors (i.e., anthropometric and laboratory indicators)?
3. List the primary sequelae of poorly managed metabolic syndrome.
4. What sort of lifestyle modifications would you discuss with Dante in order to improve the management of his condition?



Image Source/Getty Images

or no production of the hormone insulin by the pancreas (type 1 diabetes), or defective production of insulin and insulin resistance (type 2 diabetes). In type 2 diabetes, circulating insulin is high, and cholesterol, triglycerides, and blood pressure are commonly elevated. Overweight is also characteristic of type 2 diabetes. Another type of diabetes, gestational diabetes, is discussed in Chapter 5. Of primary concern for adults is type 2 diabetes.

Prediabetes

There is a long presymptomatic phase called **prediabetes** in which blood glucose levels are marginally elevated and vascular changes occur.[80] People with untreated intermediate hyperglycemia are at high risk of developing type 2 diabetes in 5–10 years; however, some do revert back to normal levels without treatment.[81] The landmark Diabetes Prevention Program (DPP) study found that an intensive program of weight loss (7 percent of body weight) and physical activity (150 minutes per week), using the therapeutic lifestyle change program approach discussed earlier, reduced the conversion from prediabetes to diabetes by 58 percent and reduced cardiovascular risk factors, and long-term follow-up found positive benefits of prediabetes intervention lasting more than 10 years.[82] The DPP and similar studies have led to a greater emphasis on screening for prediabetes and intervention before typical diabetes symptoms occur.

prediabetes A condition in which blood glucose levels are higher than normal but not high enough for the diagnosis of diabetes. This intermediate hyperglycemia state is characterized by impaired glucose tolerance, fasting blood glucose levels between 100 and 125 mg/dL, or elevated A1c.

Prevalence of Diabetes

In the United States, over 28 million adults have diagnosed diabetes; another 9.9 million have undiagnosed diabetes;[46] that is about 1 in 10 Americans. On top of that, it is

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estimated that over 113 million have prediabetes.[46] Type 1 diabetes accounts for over 5 percent of diabetes cases, type 2 accounts for about 90 percent, and gestational diabetes and other types of diabetes account for the remainder.[83]

The rising prevalence of diabetes correlates with the rise in overweight and obesity. Although most often diagnosed in people over the age of 40, type 2 diabetes is becoming increasingly common in children, adolescents, and younger adults who are overweight.

Racial and ethnic minorities bear a disproportionate burden of the diabetes and its complications. They have higher prevalence rates, worse diabetes control, and two to four times the rate of complications, such as renal disease requiring dialysis, blindness, amputations, and cardiovascular mortality of European Americans. However, an additional concern is disparity in diagnosed diabetes that is related to geography and socioeconomic factors across all racial/ethnic groups—resulting in economically disadvantaged persons not being screening and diagnosed appropriately.[84] Many customized, culturally specific diabetes outreach, care, and education programs have been developed to address these disparities.

Etiology of Diabetes

Type 1 diabetes is a progressive autoimmune disease in which the beta cells of the pancreas that produce insulin are destroyed by the body's own immune system. It has a relatively quick onset and exogenous insulin is needed for survival. A genetic predisposition, along with environmental factors, such as a childhood viral infection, are involved.

Type 2 diabetes develops over time. Insulin is present but it cannot do its job of facilitating transport of glucose into cells. This insulin resistance is strongly associated with visceral adiposity.[85] It affects muscle, fat, and liver cells in different ways. Insulin resistance in fat cells leads to the mobilization of stored lipids in these cells and elevates free fatty acids in the blood plasma. Insulin resistance in muscle cells reduces glucose uptake and interferes with muscle storage of glucose as glycogen. Insulin resistance in liver cells results in impaired glycogen synthesis and a failure to suppress glucose production. These metabolic alterations contribute to hyperglycemia. High plasma levels of insulin and glucose due to insulin resistance are believed to be the origin of metabolic syndrome and type 2 diabetes, including its complications.[76] High insulin also affects the arterial walls throughout the body and leads to hypertension. Over time, there is a progressive loss of beta-cell insulin secretion and exogenous insulin may become necessary.

Physiological Effects of Diabetes

Diabetes is a progressive disease. In the short run, untreated or poorly controlled diabetes with sustained hyperglycemia produces frequent urination as the body tries to excrete extra glucose, increased thirst, increased hunger, fatigue, weight loss, blurred vision, increased susceptibility to infection, and delayed wound healing. In the long run, diabetes contributes to heart disease, hypertension, blindness, kidney failure, liver disease, stroke, and the loss of limbs due to circulatory and neurological changes. Recently, some cancers and Alzheimer's disease have been added to the list.[85]

Micro- and macrovascular complications typically develop in people with diabetes. Oxidative stress (Chapter 3) related to hyperglycemia is believed to be a mechanism underlying vascular changes. Microvascular damage to capillaries in the back of the eye results in retinopathy and eventual blindness; in the kidneys, it causes nephropathy, leading to reduced kidney function and renal failure requiring renal dialysis, and in nerves, it causes neuropathy and loss of feeling in hands and feet. Macrovascular changes (atherosclerosis in large vessels) are accelerated by diabetes, resulting in earlier onset of cardiovascular diseases. As a result, heart disease, not diabetes, is the number-one cause of death among people with diabetes.

Screening and Assessment

Diabetes Status The American Diabetes Association recommends that adults should be screened for type 2 diabetes or prediabetes if they are 35 years old, or earlier if they are overweight (BMI ≥25, or ≥23 if Asian American) and have one or more additional risk factors, and then at a minimum of every 3 years.[85] The risk factors for diabetes and prediabetes include:

- Parent or sibling with diabetes
- History of gestational diabetes or delivery of an infant weighing more than 9 lb
- Elevated hemoglobin A1c (A1c), impaired fasting glucose (IFG), or impaired glucose tolerance (IGT) on a previous test
- Racial or ethnic background associated with an increased risk (Black, Native American, Asian American, Pacific Islander, or Latinx)
- Sedentary lifestyle and physical inactivity
- Hypertension
- Low HDL cholesterol, high triglycerides, or CVD
- Woman with polycystic ovary disease

Go to the American Diabetes Association website (diabetes.org/risk-test) and look at the "Are You At Risk" tab to determine your risk for type 2 diabetes. The diagnosis of diabetes requires confirmed glucose intolerance verified by either an A1c test, fasting plasma glucose test, or an oral glucose tolerance test.[85] Criteria for screening, diagnosis, and for assessment of glycemic control during treatment are shown in Table 17.11.

After diabetes is diagnosed, fasting plasma glucose and A1c are tested and compared to treatment goals to assess glycemic control. The A1c indicates the average blood

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Table 17.11 Laboratory values used for prediabetes and diabetes screening and management in adults

	Normal Range	Screening and Assessment	Treatment Goal
Screening			
Random capillary glucose, mg/dL[a]	70–150	≥200	
Clinical Assessment			
Fasting plasma glucose, mg/dL	70–100		
Prediabetes		100–125	<126
Diabetes		≥ 126	
2-Hour, 75-g OGTT[b], mg/dL	≥140		
Prediabetes		140–199	
Diabetes		≥200	
A1C, %	4.0–5.9		
Prediabetes		5.7–6.4	<7.0
Diabetes		≥6.5	
Individualized A1C, %			<8.0
Self-Monitored Blood Glucose			
Preprandial capillary glucose, mg/dL			80–130
1–2 hour postprandial capillary glucose, mg/dL			<180

[a] To convert these Conventional Units to SI Units, refer to the Conventional Units and SI Units table in Appendix A.

[b] OGTT–oral glucose tolerance test.

Source: Based on American Diabetes Association. Standards of Medical Care in Diabetes—2023. *Diabetes Care*. 2023; 46(Suppl 1).

glucose concentration over the previous 120 days. A1c levels can range from below 6 percent (normal range) to as high as 25 percent in uncontrolled diabetes.

Nutrition Assessment

Nutrition assessment of the person with diabetes includes many of the same areas as listed in Table 17.4. Of primary importance is understanding the individual's goals related to lifestyle and management of diabetes. Listed below are other types of information important for determining the individual's needs, tailoring a diabetes management plan, planning patient education and counseling, and monitoring progress and adjusting the plan over time. [86-88]

- Weight status and changes
- Current eating pattern; types and amounts of food typically eaten throughout the day, especially types and amounts of carbohydrate
- Knowledge about diabetes and how food intake and physical activity relate to blood glucose changes
- Usual physical activity and opportunities and interests for increasing physical activity
- Laboratory values for glycemic control (Table 17.11), self-monitored blood glucose records, and hypoglycemia or hyperglycemia events
- Medical history relevant to management of diabetes and comorbidities, CVD risk factors and disease, lipid profile, and blood pressure
- Medications for glycemic management and others, and supplement use
- Social, financial, and environmental factors impacting diabetes self-management
- Past education about and experience with meal planning, carbohydrate counting, or exchange lists, and attitudes about diabetes and expectations for medical management and outcomes

Interventions for Diabetes

Management of Diabetes Diabetes studies in the 1990s with people newly diagnosed with type 1 and type 2 diabetes demonstrated that intensive lifestyle change interventions with target A1c levels at near-normal levels (<7 percent) could prevent or delay the development of microvascular complications of diabetes (retinopathy and nephropathy) by several years.[85-88] These intervention programs were intensive in terms of the amount of time dedicated to diabetes self-management education, coaching, and support, and in terms of the targeted level of glucose control. A significant contribution of these studies was verifying the effectiveness of interventions that incorporate cognitive behavioral change strategies (as described earlier in this chapter). Subsequent studies among people with a longer duration of diabetes found improved glycemic control and reduced need for medications as well as significant, but smaller, benefits in cardiovascular outcomes. For some, tighter control was associated with more episodes of hypoglycemia.[85-88]

The clinical goals for management of prediabetes and diabetes are to normalize blood glucose and glucose metabolism, and prevent or slow the development of diabetes complications, as well as to normalize lipid levels and blood pressure. For most, this also means weight reduction. These goals are accomplished utilizing medical nutrition therapy, physical activity, and medications.[85–88] According to the Standards from the American Diabetes Association, building positive health behaviors and maintaining psychological well-being are foundational for achieving diabetes treatment goals and maximizing quality of life. Essential to achieving these goals are DSMES, medical nutrition therapy (MNT), routine physical activity, smoking cessation counselling when needed, and psychosocial care.[85] Principles at the foundation of diabetes care are *patient-centered diabetes care* and *self-management education and support (DSMES).*

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Patient-centered care is provided by a collaborative, interdisciplinary team that includes a physician, nurse, registered dietitian nutritionist, and the patient. Additional team members might be a pharmacist, health educator, exercise physiologist, or psychologist. Patient-centered care is personalized care that considers the individual's medical issues as well as social determinants of health factors, while being respectful of, and responsive to, patient preferences, needs, and values. The person with diabetes is the central member of the team because the treatment focus is on empowering him/her to self-manage diabetes and maintain good control of blood glucose levels and other metabolic indicators throughout life. Engagement of family members and support people is also important.[85]

Diabetes self-management education and support (DSMES) is an ongoing process of facilitating the knowledge, skill, and ability necessary for prediabetes and diabetes self-care and quality of life. Education is based on a curriculum, but tailored to each person's needs and preferences, treatment goals, and individualized lifestyle plan. Support is provided to encourage change and maintenance of healthy diabetes-related behaviors and to address psychosocial concerns.[85-88] Individualized and culturally and age-appropriate DSMES leads to improved self-care behaviors and healthy coping strategies, improved clinical outcomes such as lower A1c and weight loss, and lower medical costs.[85] Four critical times to evaluate the need for DSMES are at diagnosis, annually and/or when not meeting treatment targets, when complicating factors develop (medical, physical, psychosocial), and when transitions in life and care occur.

Telemedicine, which improves access to care, and virtual group education are increasingly being used for education and ongoing support to improve diabetes management. In-person and technology-based delivery of DSMES are both effective. Providing self-management support from lay health coaches, navigators, or community health workers are additional approaches that help those from disadvantaged and underserved communities.[85]

Management Targets

The target indicator for diabetes management is an A1c of 7 percent or below. Less stringent A1c goals may be set depending on the duration of diabetes, age/life expectancy, awareness of hypoglycemia, and other individual patient considerations.[85-88] Weight loss, with a target of ≥5 percent of body weight, is frequently a goal for those with prediabetes and type 2 diabetes because of its positive effect on insulin resistance, lipid profile, and longer-term complications.[85-88]

Medical Nutrition Therapy for Diabetes

There is no "diabetes diet." The current philosophy of dietary management of diabetes is diet flexibility within an individualized plan that is consistent with Dietary Guidelines.[86-88] Caveats specific to diabetes management are: (1) emphasize nonstarchy vegetables, (2) minimize added sugars and refined grains, and (3) choose whole foods over highly processed food to the extent possible.[85] For most newly diagnosed, and many with longstanding diabetes, dietary management means modifying their usual eating practices by shifting to regular eating times, paying attention to balanced carbohydrate intake throughout the day, and adopting more healthful eating behaviors that incorporate nutrient-rich food choices and appropriate portion sizes (balanced with physical activity and glucose-managing medications). To achieve this, individualized medical nutrition therapy from a registered dietitian nutritionist familiar with comprehensive diabetes management should be an ongoing part of care.[89] The registered dietitian nutritionist determines a caloric level matched to weight goals (maintain or reduce) and a plan that balances dietary intake with physical activity and prescribed medications to keep blood glucose within normal ranges throughout the day. In addition, comorbidities and risk factors are taken into consideration. The plan and nutrition intervention should:

- Promote and support healthful eating patterns, emphasizing a variety of nutrient-dense foods in appropriate portion sizes, to improve overall health and:
  - achieve and maintain body weight goals
  - attain individualized glycemic, blood pressure, and lipid goals
  - delay or prevent the complications of diabetes
- Address individual nutrition needs based on personal and cultural preferences, health literacy and numeracy, access to healthful foods, willingness and ability to make behavioral changes, and existing barriers to change
- Maintain the pleasure of eating by providing nonjudgmental messages about food choices while limiting food choices only when indicated by scientific evidence
- Provide an individual with diabetes the practical tools for developing healthy eating patterns rather than focusing on individual macronutrients, micronutrients, or single foods
- Include ongoing counseling and education and follow-up, and make adjustments as needed based on life circumstances, preferences, and disease course

patient-centered care An approach to care that that considers the individual's medical issues as well as social determinants of health factors, while being respectful of, and responsive to, the patient's preferences, needs, and values and including them in all clinical decisions.

diabetes self-management education and support (DSMES) An ongoing process of individualized education and support to facilitate the knowledge, skill, and ability necessary for prediabetes and diabetes self-care and quality of life.

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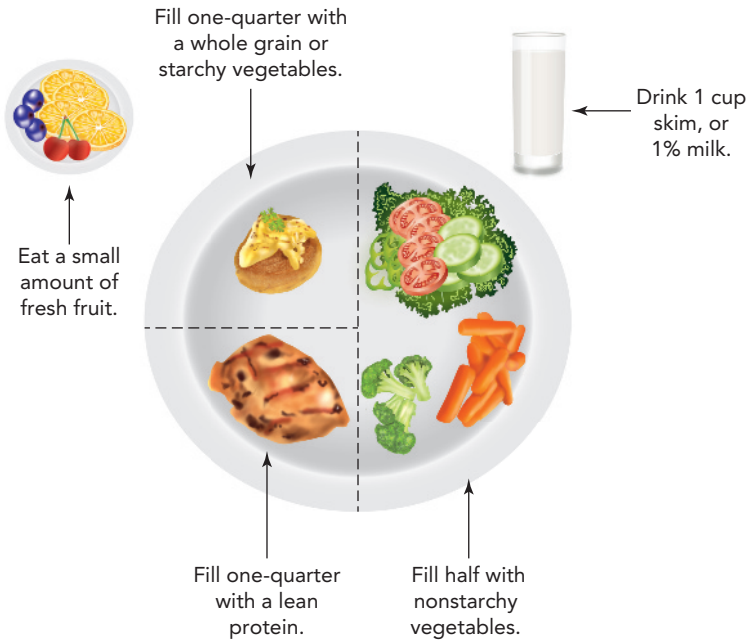


Figure 17.3 Plate method for managing dietary carbohydrate intake.

The types, amounts, and timing of foods and beverages consumed determines blood glucose, as well as the response of insulin secretion, if available. Digestion converts dietary carbohydrate (both naturally occurring in food and added sugar and starch) to glucose. A consistent eating pattern or **eating plan** (regular timing of meals and snacks and amount eaten, especially carbohydrates) helps moderate blood glucose levels, and minimize spikes and valleys throughout the day. Reducing overall carbohydrate intake has the most evidence for improving blood glucose levels and may be applied in a variety of eating patterms.[85] Strategies for managing carbohydrate intake include the plate method, based on MyPlate (Figure 17.3), or counting grams of carbohydrates at each meal and snack. A more complicated method of exchange lists for all food groups has been phased out. Selecting foods based on glycemic index and glycemic load is controversial. Some studies found a modest benefit (reduction of A1c by 0.2–0.5 percent).[90] Research is also mixed on the effects of low-carbohydrate and very-low-carbohydrate eating plans for people with diabetes.[91,92] Ongoing counseling and education is important for managing the nutrition component of diabetes managment.[85-89] Visits are recommended every 3–6 months.

eating plan A plan for timing of meals and snacks and types and amounts of foods eaten to achieve nutrition goals.

Carbohydrate Management

Carb Counting Foods are classified in groups that have similar carbohydrate, protein, and fat profiles and thus have approximately the same effect on blood glucose as other foods in the group. This makes carbohydrate counting ("carb counting") easier as the focus is on the carbohydrate content of foods (Table 17.12). The amount of carbohydrates allowed per meal is based on body size and activity level and typically ranges from 45 g for women (three servings) to 60 g for men (four servings per meal). Planned snacks are typically 10–30 g. Using reference lists, servings of food are selected to reach a specific number of grams of carbohydrate at a meal. Based on a meal being served or choosing from a menu, what and how much to eat can be determined by knowing that each serving from the grain, starchy vegetable, fruit, legume, and dairy groups is counted as having 15 g per serving. Nutrition Facts on food labels can also be used to determine grams and serving size. Using an eating plan and carb counting helps achieve consistent intake at meals and snacks throughout the day, and from day to day. Those using insulin strive for consistency, but can adjust units of insulin to the amount of carbohydrates in a meal. Measuring food and using carb-counting food lists and Nutrition Facts on food labels are recommended at the beginning.

After becoming well versed in carbohydrate counting and understanding their blood glucose response, some adults can routinely use experience-based estimates instead of counting carbohydrate grams at each meal.

Plate Method The diabetes plate method is not as accurate as carb counting, but is easier to learn and is a good starting point for some people newly diagnosed with prediabetes or type 2 diabetes. A small, 9-in. dinner plate is divided in half. The first half is filled with about 1 cup of nonstarchy, low-carbohydrate vegetables (asparagus, broccoli, green beans, salad greens, zucchini). The other half is divided again. One quarter is used for a serving of a lean protein source (3 oz skinless chicken, lean beef or fish, eggs, cheese, tofu). The other quarter is used for a serving of a carbohydrate food (grains and starchy foods such as corn, brown rice, potato, whole-grain bread, pasta). On the side is a small serving of fresh fruit, and dairy is included as a small glass of low-fat milk or a serving of yogurt. After becoming familiar with serving sizes and types of food, many advance to carb counting, which allows greater flexibility of food choices and combination dishes.

Self-Monitored Blood Glucose

Self-monitoring of blood glucose (SMBG) levels through the use of a glucometer is a part of everyday life for

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Table 17.12 Food lists for carbohydrate counting: 1 serving = about 15 g of carbohydrates

Breads and Cereals	Starchy Vegetables
• 1 slice bread (1 oz) • 1 tortilla (6-in. size) • ¼ large bagel (1 oz) • ½ hamburger or hot dog bun (1 oz) • ¾ cup ready-to-eat cereal • ½ cup cooked cereal • ⅛ of 12-in. pizza crust	• ½ cup peas, corn, or winter squash (cooked) • ½ cup lentils, pinto beans (cooked) • ½ cup mashed or boiled potatoes (cooked) • ½ med baked potato (regular or sweet) • 10–15 French fries • 1 cup vegetable soup
Fruits	**Sweets and Snacks**
• 1 small fresh fruit (4 oz) • ½ cup canned fruit • ¼ cup dried fruit • 17 small grapes (3 oz) • 1 cup melon or berries • ½ cup orange or apple juice	• 2-inch square cake (unfrosted) • 2 small cookies • ½ cup pudding • ½ cup ice cream or frozen yogurt • ¾ oz pretzels, potato or tortilla chips • 3 cups popcorn (popped)
Milk and Dairy	**Casseroles and Mixed Dishes**
• 1 cup fat-free or reduced-fat milk • 1 cup soy milk • 6 oz yogurt (light or sugar-free)	• Count 1 cup of casserole or other mixed foods as two carbohydrate servings

people with diabetes.[85] Tracking the values helps the individual see their pattern of blood glucose and how it responds to physical activity and eating various amounts and combinations of food. Continuous blood glucose monitoring (using a device inserted in the abdomen or upper arm) and smartphone apps are now making tracking easier. Information about current blood glucose levels can be used to adjust diet and exercise (and to adjust insulin, if used) to minimize blood glucose swings. The record is also reviewed at each clinic visit to assess control and make adjustments in individual's diabetes management plan.

Physical Activity in Diabetes Management

Physical activity is an integral part of lifestyle interventions to prevent progression of prediabetes, and it is important in the management of type 1 and type 2 diabetes.[85-88,93] The benefits of regular physical activity include aiding weight loss, promoting lean body mass and reducing adipose tissue, maintenance and improvement of the insulin/glucose profile, as well as reducing lipids and blood pressure.[85] National physical activity recommendations, as described in Chapter 16, also apply to people with diabetes.[38,85,93] Physical activity and sedentary time should be assessed at the baseline; then, recognizing the individual's diabetes-related health complications and other factors, target goals for improvement are established and supportive strategies and resources are identified.[85,93]

Exercise facilitates the uptake of glucose by muscle cells; therefore, individuals with type 1 diabetes must learn to reduce their insulin dose and increase carbohydrate intake to minimize blood glucose swings during and after exercise. Frequent SMBG is recommended to learn how the body responds to various types, duration, and intensities of physical activity. Consistent daily physical activity that includes aerobic exercise supplemented with resistance exercise is recommended over sporadic, intensive bouts of physical activity.[38,93] Further, duration of sedentary time (sitting) should be reduced by standing, stretching, and moving 5–15 minutes of each hour.[94]

Pharmacotherapy for Type 2 Diabetes

Lifestyle change (diet and exercise) is successful for about 30 percent of patients with type 2 diabetes. However, metformin, which reduces blood glucose by decreasing the amount of glucose released by the liver and increases glucose uptake by the muscles, is typically prescribed as an adjunct to lifestyle change for newly diagnosed type 2 diabetes and those with prediabetes and a BMI >35, especially if 35 to 59 years or with elevated fasting glucose or A1c, or history of gestational diabetes.[85] Oral antihyperglycemic drugs are added if glycemic goals are not reached in 6–12 weeks of lifestyle interventions or at any time as an intensification step if treatment goals or not being reached.[85] They have five primary mechanisms of action: (1) stimulate the pancreas to produce more insulin; (2) increase the response to insulin at cell receptor sites; (3) decrease amount of glucose released by the liver; (4) reduce digestion of polysaccharides to delay absorption of glucose from the gut into the blood; and (5) increase glucose excretion by kidneys. Unfortunately, a side effect of some antihyperglycemic medications is weight gain.

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For individuals with type 1 diabetes, a planned regimen of insulin, injected intramuscularly using multiple daily injections or continuous subcutaneous administration through an insulin pump, is required. Insulin is also used in type 2 diabetes when the A1c is ≥10% or the blood glucose is ≥300 mg/dL.[85]

Anti-obesity medications can be used as an adjunct to diabetes therapy for those who are obese and have a comorbid condition. Additional medications are also prescribed for patients who have hypertension or high cholesterol or who are at risk for atherosclerosis, heart failure, or chronic kidney disease to help manage the progression of those comorbidities.[85]

Metabolic Surgery

If hyperglycemia is inadequately controlled despite lifestyle therapy (diet, physical activity and behavioral counseling) and pharmacotherapy, and the BMI is ≥30, bariatric/metabolic surgery is considered as the next level of treatment in type 2 diabetes.[85] Metabolic surgery strongly improves glycemic control and often leads to remission of diabetes, improved quality of life, improved cardiovascular outcomes, and reduced mortality.[85] For those who undergo metabolic surgery, long-term medical and behavioral support and routine monitoring of micronutrient, nutritional, and metabolic status is necessary.[85,88]

Herbal Remedies and Other Dietary Supplements

Numerous dietary supplements are promoted as being effective for blood glucose control and the prevention of diabetes complications. Many botanicals have been tested in studies, and a few have some weak scientific evidence of safety and effectiveness. For example, bitter melon (karela), cinnamon, and fenugreek have hypoglycemic action; ginseng may decrease carbohydrate absorption and increase glucose transport; and gymnema may stimulate beta cells and increase insulin release. Although some of these are used by complementary and integrative medicine practitioners, their use is not supported by evidence-based practice standards.[88]

The role of vitamin D in insulin resistance and potential effects of supplementation on glucose homeostasis have been investigated without conclusive findings.[95] Similarly, the potential therapeutic role of chromium in glucose and lipid metabolism is an area of controversary.[96] The bottom line is dietary supplements are pharmacologically active substances that have side effects as well as potential drug interactions. If used to complement diabetes treatment, caution is necessary.[88]

carcinogenesis The process by which normal cells are transformed into cancer cells. It includes activation, initiation, promotion, progression, and invasion and metastasis. Dietary constituents can modify the process at several points along the continuum.

17.5 Cancer

Cancer is a group of diseases in which genes malfunction, resulting in unregulated cell growth and tumor formation. **Carcinogenesis**, the process by which normal cells are transformed into cancer cells, is complex and moves through several stages. The stages are activation (from inactive or quiescent state), initiation (injury or insult to DNA by a carcinogen such as free radicals, toxin, virus, or radiation), promotion (damaged DNA divides during a lag period, potentially over 10–30 years), progression (uncontrolled growth of cancer cells), invasion and metastasis (spread to other tissues and organs), and possible remission (successful treatment or reversal). Dietary elements can modify carcinogenesis at several points along the continuum of stages—some by promoting (e.g., aflatoxins, red meat, alcohol) and others by inhibiting (e.g., cruciferous vegetables, phytoestrogens in soybeans).[97] Cancers can originate in any cell, but the majority develop in epithelial tissue, where cells replicate at a high rate. Examples of epithelial cancers include the skin, lungs, prostate, breast, colon and rectum, uterus, pancreas, oral cavity, esophagus, stomach, and urinary tract. Since most cancers take many years to develop, the chance of a cancer diagnosis increases with age.

Cancer is considered a preventable disease because modifiable environmental exposures and lifestyle factors have been identified for most cancers. Cancer is also considered a chronic disease because the majority of those diagnosed have an extended posttreatment survival period where the disease is in remission or "cured." Cancer survivorship is a growing practice area dedicated to improving the length and quality of life of those diagnosed with cancer.[98]

Prevalence of Cancer

Each year, over 1.9 million people are diagnosed with cancer (not counting skin cancers), and over 609,000 die from cancer.[99] Cancer deaths have declined in all major racial/ethnic groups (due to decrease of smoking and improved early detection), yet cancer is the first leading cause of death for adults aged 45–65, and after injuries is the top medically related cause of death for adults 24–44. Overall incidence (diagnosis of new cases) has decreased for men and stabilized for women. The American Cancer Society (ACS) estimates that there are 16.9 million cancer survivors.[99] Cancer types and rates vary across populations, with Black men and White women having the highest incidence rates of cancer. Five-year survival rates are lowest for Black Americans. Contributing to the development of cancer are inequities related to the social determinants of health that mediate food access and diet quality, physical

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activity, health insurance status, and environmental exposures.[100] Economic and social barriers to cancer prevention programs, screening for early detection, and access to high-quality, ongoing treatment services are reasons behind the disparity in cancer morbidity and mortality.[99]

Etiology of Cancer

Cancer development is age-associated but not age-dependent. As people age, it becomes more likely that some insult or error will damage RNA or adversely affect the DNA replication process, and ultimately cause cancer. In healthy, resilient individuals, initiation may be repaired and subsequent cancer avoided or delayed. Factors related to cancer advancement through promotion and progression include impaired immunity or suffering from major physiological stress.

Cancer is caused by exogenous (environmental) and endogenous factors. Environmental factors include tobacco smoke, infectious agents, radiation, chemicals (some of which become concentrated in the food supply), and carcinogenic agents in food or resulting from food preservation or cooking methods.[97] Epithelial tissue, where a majority of cancers originate, has the greatest exposure to these environmental carcinogens. Endogenous factors include inherited genes, genetic mutations, accumulated genetic defects as people age, oxidative stress, inflammation response, and hormonal activity. Obesity is a factor in the development of some cancers, specifically endometrial, prostate, colorectal, pancreatic, and breast.[101] In addition to promoting chronic low-grade inflammation, nutrient excess establishes a state of cellular and systematic anabolism characterized by increased expression of growth factors, including insulin. This produces a cellular environment conducive to survival and growth of cancer cells.[101] Moreover, adiposity interferes with the action of some anticancer therapies.[102]

Lifestyle behaviors such as smoking, food choices, alcohol use, sleep patterns, and physical activity ultimately affect inflammatory, endocrine, and metabolic pathways that intensify or diminish cellular exposure and response to cancer promoting agents. A European study of cancer and nutrition confirmed that the risk of developing most types of cancer was significantly related to the number of lifestyle recommendations followed (refer to modifiable risk factors below).[103]

Physiological and Psychological Effects of Cancer

A cancer lesion damages the cells, and eventually the function of the organ and system where it is located. The impact could be localized as in skin cancer, or have widespread effects such as the impact of pancreatic cancer on digestion, absorption, and metabolism. Pain, fatigue, and emotional stress are commonly associated with cancer. Psychological stress is compounded by the loss of income and health-care costs.

Screening and Assessment

Modifiable Risk Factors and Primary Prevention

Although smoking is the most recognized contributor to cancer occurrence and death, other factors including obesity and insulin resistance, excess alcohol consumption, and poor dietary habits are important nutrition-related risk factors for developing cancer.[97,103] The list of foods, nutrients, and biologically active components of food that have been implicated in cancer promotion or cancer protection grows continually. Table 17.13 lists factors with strong evidence linking them to cancer prevention. Different dietary components have been implicated in different types of cancer.[97] A recent umbrella review of observational (epidemiological) studies found strong or highly suggestive evidence to support: (a) the positive association of alcohol consumption and risk of colon, rectum, breast, esophageal, head and neck, and liver cancer; (b) the inverse association of calcium, dairy, and whole-grain consumption and

Table 17.13 Diet, nutrition, and physical activity factors and prevention of cancer

Increase Cancer Risk*	Decrease Cancer Risk**
Aflatoxins	Calcium supplements (colorectal cancer)
Alcoholic drinks* **	Coffee
Arsenic in drinking water	Dietary fiber
Beta-carotene supplements (high dose)	**Dairy products*** (colorectal cancer)**
Cantonese-style salted fish	Nonstarchy vegetables and fruits
Fast food	**Whole grains*** **
Glycemic load	Mediterranean-type dietary pattern
Maté	Physical activity (moderate and vigorous)
Processed meat	Walking
Red meat	Having been breastfed
Salt-preserved foods	Lactation
Sugar-sweetened drinks	Body fatness in young adulthood (females—breast cancer)
Western type diet (high sugar, meat, and dietary fat)	
Screen time (marker for sedentary activity)	
Adult attained height (marker for early development, growth, and metabolism)	
Adult weight gain	
Greater birthweight	
Greater body fatness	

*Convincing or probable evidence for increased risk.

**Convincing or probable evidence for decreased risk.

***Strongest evidence from Papadimitriou, N., et al., 2021.

Source: Based on World Cancer Research Fund/American Institute for Cancer Research. Diet, Nutrition, Physical Activity and Cancer: A Global Perspective, Continuous Update Project: 2020–2021 Food, Nutrition, Physical Activity and the Prevention of Cancer. Strong Evidence Matrix. Available at https://www.wcrf.org/diet-activity-and-cancer. 2021.

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risk of colorectal cancer; and (c) the inverse association of coffee consumption and risk of liver and skin basal cell carcinoma.[104] Obesity is associated with cancer occurrence, recurrence, and mortality; and high BMI and insulin resistance are predictive of poor cancer prognosis.[102] For cancer survivors, excess weight and low physical activity adversely affect the quality of life and may worsen prognosis.[105]

Primary Prevention Early screening of lifestyle behaviors, conducted through worksite wellness and community programs, fitness centers, clinics, online assessments, and smartphone apps, identifies behaviors that, if changed, can reduce individuals' risks for development of cancer. Cancer screening during medical checkups and tests such as the Pap test, mammogram, and colorectal cancer screening seek to identify cancer at an early treatable stage. Recognition of disparities experienced by sociodemographically disadvantaged groups and persons in isolated or marginalized populations, such as the LGBTQ+ and HIV communities and people with mental health issues, has led to many initiatives to improve cancer screening, diagnosis, treatment, and outcomes for vulnerable populations. Expansion of eligibility for health insurance is an important one. Other successful approaches include community-based education and outreach and screening, financial incentives to participate in screening, and culturally tailored education and navigation services after a diagnosis is made.[100]

Nutrition Assessment Following Diagnosis and During Treatment Nutrition assessment determines the complete nutritional status of the patient and identifies if and what nutrition therapy is needed. Nutrition assessment areas are outlined in Table 17.4. Areas of focus for cancer include:

- Anthropometrics and physical exam: usual weight and recent weight loss or gain, body composition, muscle wasting
- Food and nutrition history: appetite, food tolerance and aversions, energy intake, nutrient adequacy or shortfalls, supplement use, knowledge of appropriate strategies to optimize nutritional intake in the context of the specific type of cancer and treatment
- Medical and social history: cancer type and treatment, side effects, support system, and resources to meet nutritional needs and physical functioning
- Laboratory markers of malnutrition, inflammation, and hypermetabolic stress[101,106]

anorexia Loss of desire to eat or aversion to food related to disease, treatment, and/or emotional distress.

cachexia A complex metabolic syndrome characterized by progressive loss of body weight, fat and muscle, systemic inflammation, and negative protein and energy balance.

Finding and treating nutrition problems early may help the individual with cancer gain or maintain weight, improve the patient's response to therapy and reduce complications of treatment, and improve the patient's prognosis. Assessment is done before beginning anticancer therapy, and assessment and monitoring continues throughout treatment. Validated screening and assessment tools, such as the Patient-Generated Subjective Global Assessment (PG-SGA), are widely used in oncology to determine and prioritize nutrition care and support needs, and to formulate a plan with the patient and caregivers and the medical team.[106]

Nutrition Interventions for Cancer

Nutrition intervention for cancer differs significantly, depending on the stage of care, as follows.

Prevention Healthy diet and regular physical activity (Table 17.14) with caloric intake adjusted to achieve and maintain weight within normal ranges are advocated to reduce risk of cancer development.[97]

Treatment Medical nutrition therapy is a part of care during treatment with chemotherapy, radiation, and surgery and recovery to restore nutrient shortages, maintain nutritional health, and prevent or manage complications.[106] Anticancer medications and radiation treatments are associated with nausea, vomiting, diarrhea or constipation, fatigue, and weight loss. Nutrition modifications help the people with cancer cope with the effects of cancer and its treatment. In addition to those mentioned previously, side effects that interfere with eating include taste aversions, **anorexia** (loss of desire to eat), mouth sores, trouble swallowing, pain, depression, and anxiety.[107] **Cachexia**, a progressive loss of skeletal muscle, fat, and body weight, is common in cancers of the digestive tract and advanced stages of cancer. It results from a combination of reduced food and nutrient intake, altered absorption and metabolism, increased nutrient and energy demands of the tumor, excessive catabolism and inflammation, and response to treatment.[108] Registered dietitian nutritionists individualize nutrition recommendations according to each patient's symptoms, treatment, nutritional status, cultural and religious preferences, and tastes for food. Foods and beverages that are high in calories, protein, vitamins, and minerals are usually advised. Some cancer treatments are more effective and better tolerated if the patient is well nourished. Enteral or parenteral nutrition supports (nutrition formulas delivered by tube to the gastrointestinal tract or directly into the circulatory system) are sometimes used. Getting enough calories and protein is important for healing, fighting infection, and providing energy, preserving muscle mass, and maintaining stamina; and being well nourished is linked to better prognosis.[106,108]

Periods of Remission Healthy eating is encouraged for cancer survivors in the same way as for the general population. Lifestyle interventions can optimize health and nutritional status and may impact reoccurrence. An

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Table 17.14 Nutrition and physical activity guidelines for cancer prevention

Achieve and maintain a healthy weight.
• Be as lean as possible throughout life without being underweight. • Avoid excess weight gain at all ages; avoid increasing waist circumference. • If overweight, losing even a small amount of weight can be beneficial.
Make physical activity a part of daily routines.
• Any intentional physical activity above usual activity provides some benefit. • As a general goal, get 30 minutes or more of physical activity in daily routines. • Strive to meet national recommendations for physical activity of moderate to vigorous intensity. • Minimize sedentary behaviors such as sitting, lying down, watching TV, and other types of screen time.
Eat a healthy diet, with emphasis on plant foods.
• Choose foods and drinks in amounts that maintain a healthy weight. • Base diet on vegetables and fruits of different colors (red, purple, green, yellow, and orange) and other food from plant sources such as whole grains and beans. • Choose whole, relatively unprocessed grains rather than refined grain products. • Minimize intake of energy-dense foods (>225–275 kcal/100 g). • Use fruits and vegetables to replace snacks and empty calories. • Avoid sugar-sweetened beverages. • Avoid salt-preserved, salted, and salty foods. • Avoid processed meat and meats cooked at high temperatures. • Limit consumption of red meat to <18 oz per week, and minimize saturated fat intake.
If you drink alcohol, do so in moderation.
• Limit to no more than 1 drink per day for women and 2 per day for men. • Cancer risk increases with the amount of alcohol and the years of regular drinking.

Sources: Adapted from American Cancer Society, Mayo Foundation for Medical Education and Research, National Cancer Institute, World Cancer Research Fund/ American Institute for Cancer Research, and World Health Organization.

individualized plan for weight management and physical activity should be part of ongoing cancer care.[109]

Nutrition Care During Advanced Stages of the Disease Food and fluid intake are adjusted in accordance with the patient's wishes to manage symptoms and support quality of life.

Complementary and Alternative Medicine in Cancer Treatment

The hope for remission and cure is a powerful motivator to consider alternative medicine therapies. Many cancer patients or their families seek complementary or alternative treatments, including special regimens and nutritional and herbal supplements. Some herbal products have potentially useful roles in cancer treatment to ameliorate nausea and common symptoms. Examples include ginger capsules before and after chemotherapy treatment to prevent nausea, chamomile or ginger tea for gastrointestinal discomfort, and peppermint tea as a digestive aid. The National Cancer Institute and the National Center for Complementary and Alternative Medicine are sources of information regarding complementary and alternative treatments for cancer.[110]

Key Points

1. Overweight, obesity, and central adiposity are associated with major chronic diseases—cardiovascular disease, diabetes, metabolic syndrome, and cancer—and many other conditions in a dose-response manner.
2. Relatively small amounts of weight loss (5–10 percent of body weight) can reduce the risk for insulin resistance, diabetes, hypertension, and cardiovascular disease.

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3. Within the categories of nutrition assessment (anthropometrics, food and nutrition history, physical activity, laboratory tests, medical and health history, social history, nutrition knowledge and attitudes, and readiness to change), different things are emphasized relating to the etiology, physiological effects, and risk factors for each of the chronic diseases presented in this chapter.
4. Modifiable risk factors for cardiovascular disease are blood lipid levels; high blood pressure; and the lifestyle factors of diet, physical activity, and smoking.
5. Therapeutic lifestyle changes, alone or with pharmacotherapy, can halt or reverse the atherosclerotic process and prevent coronary events.
6. Metabolic syndrome is very common among adults who are overweight or obese. Therapy is directed to normalizing blood lipids, blood pressure, and blood glucose through diet and physical activity.
7. Among people who are overweight and have prediabetes, progression to type 2 diabetes can be halted or delayed with a weight loss of 7 percent and 150 minutes of physical activity per week, and among people with diabetes, complications can be delayed when blood glucose levels are maintained at near-normal levels.
8. Intensive and ongoing education and counseling are necessary to make lifestyle changes to manage chronic disease and prevent complications.
9. Nutrition intervention in cancer depends on the stage of care: prevention, treatment, remission, or advanced stage.

Review Questions

1. How would you design a lifestyle-change program based on cognitive behavioral therapy?
2. What three things differentiate population recommendations to minimize cardiovascular disease risk from therapeutic lifestyle changes for individuals at high risk?
3. List the metabolic changes that characterize metabolic syndrome. How many are required for a diagnosis of metabolic syndrome? What is the easiest way to screen for metabolic syndrome?
4. Why is it better to start intervention in the prediabetic state rather than waiting for the diagnosis of diabetes?
5. List the main considerations in developing a diet plan (nutrition prescription) for an individual with diabetes.
6. What are a registered dietitian nutritionist's priorities for nutrition intervention in each of the four stages of cancer care?

The following six questions concern Lena, who is 36 years old, weighs 182 lb, and is 5-ft 4-in. tall. She just found out her LDL cholesterol is 170 and her HDL is 37.

7. Lena can be characterized as obese.
   _____ True _____ False
8. Lena should be assessed for metabolic syndrome.
   _____ True _____ False
9. Lena needs to lose over 20 lb to reduce her risk of developing type 2 diabetes.
   _____ True _____ False
10. Eating high-fiber foods a few times a week will help lower her LDL cholesterol.
    _____ True _____ False
11. What other information do you need to determine Lena's 10-year risk of having a heart attack?
12. Lena quit smoking a few years ago. What else can she do to reduce the development of cardiovascular disease?
13. Identify and discuss at least three themes that are common across all the conditions—overweight and obesity, cardiovascular disease, metabolic syndrome, diabetes, and cancer—presented in this chapter.

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18

Nutrition and Older Adults

Prepared by Nadine R. Sahyoun

Learning Objectives

After studying the materials in this chapter, you should be able to:

18.1 Distinguish three or more reasons why functional status is a better indicator of health in older adults than chronological age.

18.2 Discuss the distinctions between life expectancy and life span, and address implications for society of increases in both.

18.3 Defend the statement: "Diseases and disabilities are *not* inevitable consequences of aging."

18.4 List five physiological changes occurring at ages 70+ and describe nutritional implications for each.

18.5 Describe the relative effectiveness of two nutrition screening and assessment tools.

18.6 Relate how enjoying a varied diet contributes to mental and physical well-being.

18.7 Compare nutrient recommendations of old and young adults, citing five or more nutrients of concern for older populations.

18.8 Explain how good food-safety practices contribute to the health of older adults, and how increasing functional decline can be accommodated.

18.9 Summarize the heterogeneity of older adult populations and suggest two or more reasons to tailor health promotion.

18.10 Describe one or more nutrition programs serving older adults.

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Introduction

Aging is a natural phenomenon. It reflects the physiological changes that the body undergoes over the course of a lifetime. Many of the changes may lead to a decline in resilience, however, aging is not all loss or decline. Rather, healthy aging is associated with continuing psychosocial, personal, moral, cognitive, and spiritual development.

Aging is a heterogeneous process. Everyone ages differently. Genetics, lifestyle, and disease processes all affect the way people age. Although older adults are more vulnerable to disease because of biological changes that occur over time, aging is not synonymous with disease. Aging is an ongoing process; however, there is no single way of defining old age. *Old* has been defined chronologically, biologically, psychologically, and socially. Definition of old age is important for political, economic, and medical reasons. Chronological age is being used most frequently, but one 80-year-old individual may be playing tennis while another may be in a wheelchair.

Despite the prevalence of chronic diseases that accompanies older age, 70.7 percent of adults aged 75 and older consider themselves to be in good, very good, or even excellent health.[1] More than anything, older adults want to remain independent and living in their own home.[2] Older adults believe that good nutrition and exercise will help them maintain autonomy and independence.

What constitutes good nutrition in later life? Older adults need fewer calories but their nutrient needs remain the same or even increase for some of them. This means that older adults must consume more nutrient-dense foods. Diet quality is linked to the **longevity** of older men and women.[3,4] Eating adequate amounts of vegetables, fruits, and whole grains, choosing unsaturated fats, drinking enough water to stay hydrated, and drinking alcohol only in moderation will reduce risks of developing a disease. Good health habits help to delay mortality and achieve **compression of morbidity** in older populations.[5–7] In fact, 4 of the 10 leading causes of death for people aged 65 and older[8] in the United States have nutritional risk factors—namely, heart disease, cancer, stroke, and diabetes. Of these, heart disease and cancer accounted for 44.2 percent of all deaths in the United States in 2019. In 2020, COVID-19 became one of the 10 leading causes of death.[9]

This chapter defines *aging* and provides information about the nutrient requirements, dietary recommendations, and food and nutrition programs designed to support healthy aging. Chronic conditions that affect older people's health are discussed in Chapter 19.

longevity Length of life, measured in years.

compression of morbidity Shortening the period of illness and decreased functional capabilities at the end of life.

Medicare Federal health insurance for all people age 65 and older, and for younger individuals with certain disabling conditions.

What Counts as Old Depends on Who Is Counting

Societal and governmental definitions use various chronological ages to designate who is *old*. Based on nutritional needs, the Dietary Reference Intakes (DRIs) created a category for persons aged 70 and older. The World Health Organization (WHO) uses age 60 when referring to aging populations. How does this match the perceptions of older adults? The average older adult does not feel old, however, a survey conducted by Parker Life showed that what is considered as *old* depends on one's age.[10] Overall, adult survey respondents said that old age begins at 68. However, adults under 30 considered 60 to be old, while respondents over age 65 believe that old age begins at age 75 Compared to Baby Boomers, adults under the age of 60 are more likely to consider someone old when these reach the age of 70.

Establishing an age cut-off to define old age is used for policy decisions such as, determining retirement age, disbursement of pensions and social security benefits, and eligibility for other programs and services. For example, the Older Americans Act Nutrition Program, first funded in 1972, uses eligibility criteria of 60 years and older. The Social Security Program identifies people 65 years old as being eligible for **Medicare**. These different age limits for program eligibility reflect society at the time the laws were enacted, and they affect program funding; adjusting them to meet public health needs will happen as science and the public's perceptions evolve. The arbitrarily set age of 65 years to denote an *older adult* is commonly used, and we will use it here. Chronological age is just one of many factors that affect the nutritional status of individuals.

Since there is no single biological benchmark that signals a person's becoming old, chronological age commonly serves as a proxy measure for predicting health status and functional abilities. However, functional status, a description of how well one can accomplish the desired tasks of daily living, is more indicative of health than chronological age. Rather than ask, "How old are you?" we should ask, "Can you independently do the things you want and need to do?" and "Can you shop for food?" and "Can you see or smell well enough to know if your food is moldy or spoiled?"

Food Matters: Nutrition Contributes to a Long and Healthy Life

It is human nature to seek magic bullets and super foods, but a balanced, varied, and healthy diet throughout life contributes to optimal growth, to appropriate weight, and to nutrient levels in blood and other tissues that boost immunity and provide disease resistance. In trying to assess the contribution that good nutrition can make to

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longer life, the Centers for Disease Control and Prevention (CDC) suggest that longevity depends 19 percent on genetics, 10 percent on access to high-quality health care, 20 percent on environmental factors such as pollution, and 51 percent on lifestyle factors.

Besides not smoking, diet and exercise are estimated to be the lifestyle factors contributing most to decreased mortality, or longer life. From a prospective study of over 3,000 older adults and 10 years of mortality follow-up, the results showed that individuals who consumed the "Healthy Foods" dietary pattern, characterized by relatively higher intake of fruit, vegetables, whole grains, poultry, fish, low-fat dairy products, and lower consumption of meat, fried foods, sweets, high-calorie drinks, and added fats, had reduced risk of mortality and more years of healthy life than individuals who consumed other dietary patterns.[4]

Diet contributes to reducing risk of disease and delaying death and also contributes to wellness. Wellness means having the energy and ability to do the things one wants to do and to feel in control of one's life. Being able to choose, purchase, or prepare, and eat a satisfying diet every day; enjoying traditional foods at holidays, birthdays, and other special occasions; and having the resources to purchase desired foods on a regular basis all contribute to independence and a higher quality of life. Good nutrition, as defined by dietary guidelines covered later in this chapter, can help "add life to years" as well as add years to life.

18.1 A Picture of the Aging Population: Vital Statistics

Life expectancy varies by state and county. In Florida, where Ponce de Leon was associated with the Fountain of Youth, the U.S. Census Bureau 2019 estimates put the number of residents aged 65 and older at 20 percent of the population. Maine had the highest density in all states and territories at 20.9 percent while Utah, Washington DC, and Alaska had the lowest older adult population density at 11.4, 12.4, and 12.5 percent, respectively.[11]

During Roman times, fewer than 1 percent of the population reached age 65; in 1900 it was 4 percent. According to the U.S. Census Bureau, the 65-and-older population grew by over a third (34.2 percent, or 13,787,044) during the past decade, and by 3.2 percent (1,688,924) from 2018 to 2019. This increase in the older population is driven by the aging of the Baby Boomer generation who was born between 1946 and 1964, starting after the end of World War II, when soldiers returned home.[11] The last census in 2010 estimated the number of adults aged 65 and older at 40.3 million, an increase of 15.3 percent since the 2000 census.[1] In 2019, 16 percent of the North American population was aged 65 and older, and is expected to increase to 21.6 percent by 2040.[1] Persons aged 85 years and older are the fastest-growing segment of the population, This population is projected to more than double from 6.6 million in 2019 to 14.4 million in 2040 (a 118 percent increase). Their growth rate is twice that of those 65 and over and almost four times that for the total population. Additionally, racial and ethnic minority populations increased from 20 percent of older Americans in 2010 to 24 percent in 2019 and are projected to increase to 34 percent in 2040.[1] The 1995 White House conference on aging called this age wave "a demographic revolution" and predicted that it will change the twenty-first century much as information technologies revolutionized the 20th century.[12] Housing, transportation, and medical systems will need to adapt their programs and services to meet the needs of ever-increasing numbers of older adults.[13]

Global Population Trends: Life Expectancy and Life Span

Life expectancy in the United States varies by race/ethnicity and sex (Figure 18.1). Between 2008 and 2018, life expectancy at birth increased 0.5 years to 78.7 years and decreased by 0.1 years in 2019. Also in 2019, at age 65, an individual could expect to live another 19.6 years. This is compared to a life expectancy of 47 years for someone born in 1900. However, in 2020, life expectancy declined by 1.8 years to 77.0 years. This decline in life expectancy may be attributed to COVID-19 which became the third cause of death after heart disease and cancer in 2020. The gap in life expectancy between males and females was 5.1 years in 2019. There also remains a gap in life expectancy at birth by race/ethnicity whereby, people who are Black had a life expectancy of 74.7 years in 2018 compared to those who are Hispanic or Latino at 81.8 years and compared to people who are White at 78.7.

Since the early 1900s, immunizations and other risk-reduction measures, treatment of infectious diseases, decreased infant and childhood mortality rates, and clean water and safe food have increased average life expectancies. Additionally, by the mid-20th century, there was and continues to be a decline in mortality from chronic diseases. These factors contributed to the increase in life expectancy. The Baby Boomers, who are living longer than previous generations, started turning 65 in 2011, leading to a rapid increase in the older population. The increase in proportion of older adults is a worldwide phenomenon. This is known as the **demographic transition**, which is the confluence of improved health and longevity, decline in fertility leading to growing numbers and proportions

life expectancy Average number of years of life remaining for persons in a population cohort or group; most commonly reported as life expectancy from birth.

demographic transition Transition from high birth and death rates to low birth and death rates.

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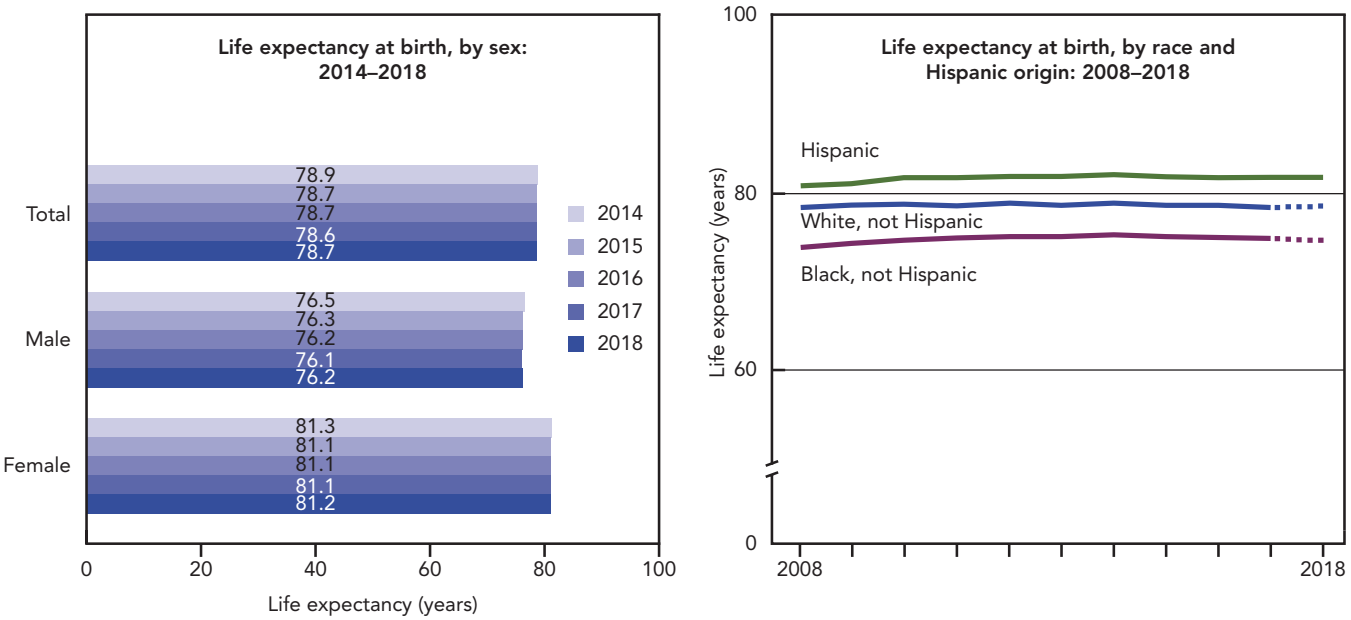


Figure 18.1 Life expectancy at birth, by sex and race and Hispanic origin: The United States, 2008–2018.[9]

Source: NCHS, National Vital Statistics System (NVSS), Mortality. Excel and PowerPoint: https://www.cdc.gov/nchs/ppt/hus/hus19fig01.pptx, accessed May 9, 2022.

of older population in most parts of the world. Table 18.1 shows life expectancies in select countries and in the United States, which ranks 46 in the world.

Although life expectancy is rising and populations are aging, the human **life span** has remained stable at around 110–120 years.[14] However, there is an increasing number of researchers who speculate that the life span may increase in the 21st century. Jeanne Calment of France is known as the oldest person, living to age 122. However, doubts were raised regarding her true age at death. Currently, the longest-living person is Kane Tanaka, who in January 2022 turned 119 years old.[15] Reaching the age of 100 has been rare enough that the president of the United States sends personal greetings to individuals for their 100th birthday. By 2050, when nearly 1 percent of the population is expected be a **centenarian**, the president might have to reserve this special goodwill gesture for **supercentenarians.**

Health Objectives for Older Adults

The Healthy People 2030 national health goals were recently released. The goal for older adults is to improve their health and well-being and its objectives for this population are to focus on reducing health problems and improving their quality of life.[16] The objectives that are specific to older adults are in Table 18.2, however, many of the other objectives stated in Healthy People 2030 are also applicable to this population. For example, the nutrition-specific goals are the same as those for individuals aged 2 and older. The greatest dietary improvement would be to eat more fruits, vegetables, and whole grains.

life span Maximum number of years someone might live; human life span is projected to range from 110 to 120 years.

centenarian Person who reaches age 100 or more.

supercentenarian Person who has reached age 110 or more, validated.

Table 18.1 Life expectancies in selected countries, using 2021 data

Rank	Country	Years*
1	Monaco	89
2	Singapore	86
4	Japan	85
6	Canada	84
8	Hong Kong	83
12	Switzerland	83
15	Korea, South	83
17	Italy	83
20	France	82
34	Puerto Rico	82
38	United Kingdom	81
40	Greece	81
46	United States	80

The CIA ranks 227 countries. Some of the shortest life expectancies are found in Afghanistan, at 53 years; Central African Republic, at 55 years; and Haiti, at 66 years.

*Years rounded to nearest whole number.

Source: Central Intelligence Agency. *The World Factbook. Country Comparisons—Life Expectancy at Birth.* Available at https://www.cia.gov/the-world-factbook/field/life-expectancy-at-birth/country-comparison, accessed February 10, 2022.

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Table 18.2 Healthy People 2030, Objectives for older adults and objective number[16]

Older Adults Objectives:
General
• Increase the proportion of older adults with physical or cognitive health problems who get physical activity—OA-01
• Reduce the rate of pressure ulcer-related hospital admissions among older adults—OA-04B
• Reduce the rate of hospital admissions for diabetes among older adults—OA-05
Dementias
• Increase the proportion of older adults with dementia, or their caregivers, who know they have it—DIA-01
• Reduce the proportion of preventable hospitalizations in older adults with dementia—DIA-02
• Increase the proportion of adults with subjective cognitive decline who have discussed their symptoms with a provider—DIA-03
Foodborne Illness
• Reduce infections caused by *Listeria*—FS-03
Infectious Disease
• Reduce the rate of hospital admissions for urinary tract infections among older adults—OA-07
Injury Prevention
• Reduce fall-related deaths among older adults—IVP-08
• Reduce the proportion of older adults who use inappropriate medications—OA-02
• Reduce the rate of emergency department visits due to falls among older adults—OA-03
Oral Conditions
• Reduce the proportion of older adults with untreated root surface decay—OH-04
• Reduce the proportion of adults aged 45 years and over who have lost all their teeth—OH-05
• Reduce the proportion of adults aged 45 years and over with moderate and severe periodontitis—OH-06
Osteoporosis
• Reduce hip fractures among older adults—O-02
• Increase the proportion of older adults who get screened for osteoporosis—O-D01
• Increase the proportion of older adults who get treated for osteoporosis after a fracture—O-D02
Respiratory Disease
• Reduce the rate of hospital admissions for pneumonia among older adults—OA-06
• Reduce hospitalizations for asthma in adults aged 65 years and over—RD-D03
Sensory or Communication Disorders
• Reduce vision loss from age-related macular degeneration—V-07
Other
• Reduce fall-related deaths among older adults—IVP-08
• Reduce the proportion of older adults who use inappropriate medications—OA-02
• Reduce the rate of emergency department visits due to falls among older adults—OA-03

Source: Healthy People 2030: Building a healthier future for all,[16] U.S. Department of Health and Human Services.

18.2 Theories of Aging

What triggers aging? Theories explaining aging grow from human desire to understand the biological processes that determine how long and how well we live. Aging theory tries to explain the mechanisms behind loss of physical resilience, decreased resistance to disease, and other physical and mental changes that accompany aging.

Biological systems are so complex that no single theory has been robust enough to explain the mechanisms of aging. Genetics are thought to account for about 25 percent of longevity.[17] Environmental factors influence expression of the genetic code by aggravating or improving certain traits. Nutritional genomics is a field that examines the interplay between genetics and nutrition; it can help to promote healthy aging by tailoring interventions to specific risk factors, such as adding omega-3 fatty acid to one's diet in an attempt to enhance gene-controlled responses to inflammation. Body composition is another area that demonstrates reactions between genes and environment. While height and weight are strongly influenced by genetic factors, individuals have some ability to control diet, activity levels, and other environmental exposures (such as smoking) to determine what their body composition

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will be in later life.[6,18] Understanding how people age can help to separate the effects of age-associated disease from changes naturally caused by aging. Such an understanding can guide prevention efforts, leading to compression of morbidity and mortality.

Theories of aging can be examined from two perspectives: (1) programmed aging theories and (2) "wear-and-tear" theories. Caloric restriction is an intervention that incorporates aspects of several aging theories to manipulate life span and morbidity.

Programmed Aging

Hayflick's Theory of Limited Cell Replication

Hayflick proposed that all cells contain a genetic code that directs them to divide a certain number of times during their life span.[14] After cells divide according to their programmed limit, and barring disease or accident, cells begin to die (some call this replicative **senescence**). For example, if individual cells of a fly have a 3-day life span and replicate 15 times, a fly can live 45 days. Using this theory, Hayflick calculated the potential human life span to be in the range of 110–120 years, estimating that human cells replicate from 40–60 times. Although most human cells can regenerate (e.g., blood, liver, kidney, and skin cells reproduce themselves), not all cells have that capacity (e.g., spinal cord nerves and brain cells). Hayflick's theory is difficult to prove in humans because we die from age-associated chronic disease more often than from old age itself.

Molecular Clock Theory

Another theory of programmed aging is that of the molecular clock. **Telomeres** that cap the ends of chromosomes act to mark time, becoming a bit shorter with each cell division. Eventually loss of telomeres stops the ability of chromosomes to replicate. Loss of chromosomal replication may produce signs of aging because new cells cannot be formed, and the function of existing cells declines with time. A major thrust of aging research is to identify ways to limit loss of telomeres and thus prolong cell replication.[19]

Wear-and-Tear Theories of Aging

Wear-and-tear theories are built on the premise that things wear out with use. Errors in the replication of cells and accumulation of damaging by-products eventually destroy the organism. Cytotoxicity (poisoning of the cell) results when damaged cell components reach critical mass and become toxic to healthy cells. Glucose binding to proteins (glycosylation) leads to accumulation of Advanced Glycosylation End-products (AGEs); cross-linking between cells stiffens collagen fibers, including those in tendons, ligaments, blood vessels, and kidneys. According to wear-and-tear theories, the accumulation of damaged cells and waste by-products leads to declining function and aging.

Free-Radical or Oxidative Stress Theory

Oxygen is an integral and versatile part of metabolic processes; it can both accept and donate electrons during chemical reactions. One cause of aging is thought to be oxidative stress due to the buildup of reactive (unstable) oxygen compounds. Unstable oxygen, formed normally during metabolism, can also initiate reactions that break down cell membranes and damage cells needed to keep the immune system intact. Exposure to oxidizing agents is increased by smoking, ozone, solar radiation, and environmental pollutants. Unstable oxygen compounds are neutralized, however, when they combine with an antioxidant. This prevents them from interfering with normal cell functions. The body produces antioxidant enzymes (such as catalases, glutathione, peroxidase reductases, and superoxide dismutase), but part of our need for antioxidants is met from our diet. Dietary antioxidants include selenium; vitamins E and C; and phytochemicals such as beta-carotene, lycopene, flavonoids, lutein, zeaxanthin, resveratrol, and isoflavones.

Rate-of-Living Theory

The rate-of-living theory is similar to the oxidative stress theory in that it suggests that "faster" living results in faster aging. For example, higher metabolic rate and greater energy expenditure leads to greater turnover of all body tissues. Theoretically, fast-paced living shortens life span, whereas living more slowly leads to a longer life. Scientists have not adequately examined old people, including centenarians, to fully understand this theory.

Calorie Restriction to Increase Longevity

If you search PubMed, you will find that most of the studies listed include non-primate organisms. Animal studies (e.g., of fruit flies, water fleas, spiders, guppies, mice, rats and other rodents, and primates) show that an energy-restricted diet that meets micronutrient needs can prolong healthy life.[20] For example, laboratory mice and rats fed calorie-restricted diets live longer and have fewer age-associated diseases than their counterparts whose diets are unrestricted. In the 1930s, McCay and colleagues suggested that delays in aging result after food restriction, due to slowed growth and development.[21] But since then, rodent studies have shown that instituting **caloric restrictions** in midlife, after growth and development were completed, results in longer life spans.[20]

Studies of caloric restriction (CR) in primates have shown conflicting results. Researchers at the Wisconsin National Primate Research Center found that adult rhesus

senescence The condition or process of deterioration with age.

telomere A caplike structure that protects the ends of chromosomes; it erodes during replication.

calorie restriction Decreasing the energy level of one's diet by 25–30 percent while meeting protein, vitamin, and mineral needs.

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monkeys fed calorie-restricted diets (at 70 percent of their previous energy maintenance level) had significantly fewer age-related deaths (the controls were three times more likely to die than the CR monkeys during the 20-year study period). They also found that CR led to delayed onset of age-related illnesses, maintenance of muscle mass at a higher level, and delayed gray matter atrophy. The authors suggest one mechanism driving these results might be that CR leads to changes in cell signaling pathways that induce metabolic reprogramming and subsequent life extension.[22] A similar study conducted by the National Institute on Aging (NIA) did not show a significant difference in survival between the CR- and control-fed monkeys.[23] Coleman and colleagues, who took a closer look at both sets of data, suggested that a possible reason for the difference in results may be that the control monkeys in the NIA study had lower body weight than the control monkeys in the Wisconsin study or even the weights of healthy, nonexperimental captive Rhesus monkey housed in research facilities across the United States. This seemed to imply that the NIA control animals were already fed a restricted diet and the difference in caloric intake between the NIA control and CR-fed animals was not large enough to show a significant difference in survival.[24] More research is needed to get a better understanding of the aging process.

Could calorie-restricted diets also extend human life? Experimental findings in small animals have led some individuals, such as Dr. Roy Walford of Biosphere 2, to personally adopt very-low-calorie diets. Walford coordinated the calorie-restricted diets of eight normal-weight people living in Biosphere 2.[25] However, such a small study lasting 2 years is too limited to determine human life-span extension results from caloric restriction, especially in the closed terrarium-like setting of the Biosphere. Luigi Fontana and colleagues tested the theory that caloric reduction also reduces a thyroid hormone (T3) that controls cell respiration and free-radical production.[26] They compared hormone levels of healthy, lean, weight-stable adults eating an 1,800-kcal diet for 3–15 years with those of two matched groups eating typical Western diets of 2,400 (sedentary group) or 2,800 kcal (exercise group). Fontana's results suggest that reducing metabolic rate and oxidative stress may slow the rate of aging.

From an ecological view, people in France and Japan have lower caloric intake than do people in the United States, and people in both of those countries also live longer (Table 18.1). Wilcox and colleagues[27] studied a cohort of older Japanese residents of Okinawa whose nutrient-dense diets provided approximately 11 percent fewer calories than estimated to meet their energy needs. Population records show that this Okinawan cohort experienced caloric restriction at least until middle age, some longer. Lower caloric intake was coupled with reduced mortality from age-associated diseases. The authors concluded that, consistent with animal literature supporting caloric restriction, "an adaptive response to early and mid-life energy restriction in the older cohort of Okinawans may be implicated in their low morbidity and exceptionally long survival."

We know that nutrition affects human longevity by moderating risks of developing chronic diseases, ameliorating certain chronic conditions, and aiding in the healing of acute conditions. Many physiological relationships seem to function well in a midrange, between the dangerous zones of insufficiency and excess. Body weight is an example. Severe caloric restriction during famine leads to malnutrition and starvation, with poor outcomes in human reproduction, growth, development, immune status, and healing, while severe obesity leads to early death. Researchers are seeking the perfect balance of nutrient and energy intake to maintain a long, healthy life.

18.3 Physiological Changes

Normal aging is associated with changes in most physiological systems, which may eventually lead to functional and structural deterioration (Table 18.3). As scientists come to understand the human aging process, they will learn to sort through age-associated physiological changes to be able to distinguish which changes are due to genetic factors and which are due to poor diets, inactivity, or other lifestyle-related factors.

Body-Composition Changes

Lean Body Mass (LBM) and Fat Of all physiologic changes that occur during aging, the biggest effect on nutritional status and physical **resilience** is due to the shifts in the musculoskeletal system. On average, there is a decline in **fat-free** or **lean body mass** of 2–3 percent per decade from age 30–70, even when weight is stable.[7] This leads to the loss of up to 15 percent of muscle mass **(sarcopenia)** (Table 18.4).

During this time, body fat increases, especially in the visceral region. The increase is gradual so individuals might not notice, especially since weight stays relatively stable because muscle is replaced by fat. But maybe one day, the person puts on their favorite old swimsuit, and the shift is obvious. Of course, the extra fat does provide a reserve of energy for periods of low food intake or recovery from illness or surgery, acts as an insulator in cold weather, and cushions falls. Losses of fat-free mass leave

resilience Ability to bounce back, to deal with stress, and recover from injury or illness.

fat-free mass Used interchangeably with lean body mass, comprising bone, muscle, water.

sarcopenia Age-associated loss of skeletal muscle mass and function.

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Table 18.3 Age-associated physiological system changes that affect nutritional health*

Cardiovascular System
• Reduced blood vessel elasticity, blood volume, stroke volume output
• Increased arterial stiffening, blood pressure
Endocrine System
• Reduced levels of estrogen and testosterone
• Decreased secretion of growth hormone
• Increase in cortisol (stress hormone)
• Reduced glucose tolerance
• Reduced levels of thyroid gland secretions
• Decreased ability to convert provitamin D to previtamin D in skin
Gastrointestinal System
• Reduced secretion of saliva and of mucus
• Missing or poorly fitting teeth
• Dysphagia, or difficulty in swallowing
• Damaged, less-efficient mitochondria produce less ATP, less energy
• Reduced secretion of hydrochloric acid and digestive enzymes
• Slower peristalsis
• Reduced vitamin B_{12} absorption
Musculoskeletal System
• Reduced lean body mass (bone mass, muscle, water)
• Increased fat mass
• Decreased resting metabolic rate
• Reduced work capacity (strength)
Nervous System
• Blunted appetite regulation
• Blunted thirst regulation
• Declining number of olfactory receptors, blood flow to nasal smell organ, and increased thickness of nasal mucus
• Reduced nerve conduction velocity, affecting sense of smell, taste, touch, cognition
• Changed sleep as the wake cycle becomes shorter
Renal System
• Reduced number of nephrons
• Slowed glomerular filtration rate
Respiratory System
• Reduced breathing capacity
• Reduced work capacity (endurance)

*Some of these age-associated changes, such as the increase in blood pressure, are usual but not normal.

Table 18.4 Comparison of body composition of a young and an old adult

	20 to 25 Years	70 to 75 Years
Protein/cell solids	19%	12%
Water	61%	53%
Mineral mass	6%	5%
Fat	14%	30%

Sources: Data from Chernoff, R. (ed.), *Geriatric Nutrition: The Health Professional's Handbook.* Sudbury, MA: Jones and Bartlett, 2014:442. Based on Shock, N. W., *Biological Aspects of Aging.* New York, NY: Columbia University Press, 1962.

older adults with lower mineral, muscle, and water reserves to call on when needed. After age 70, weight, including fat at all sites, begins to decline.[7] Body-composition changes of aging are associated with lower levels of physical activity, food intake, and hormonal changes.[28]

Muscles: Use It or Lose It Many older people expect decreases in physiologic function with increasing age. However, physical activity and regular exercise can mitigate the physiological effects of a sedentary lifestyle and delay onset or progression of chronic disease. For example, the HEalth, RIsk Factors, Training, And GEnetics (HERITAGE) Family Study compared the effects of a 20-week strength-training program on older and younger men and women, finding that the training response differed by sex and by race, but *not* by age.[29] Training exercises led to increases in fat-free mass; decreases in total, subcutaneous, and visceral fat mass; and to weight loss. Weight-bearing and resistance exercise increase lean muscle mass and bone density.[7,30] Building muscle also results in added water stores because muscle tissue contains more water than fat tissue does. Regular physical activity, including strengthening and flexibility exercise, contributes to maintenance of **functional status.**

Weight Gain Weight gain tends to accompany aging. Large cross-sectional studies show that mean body weight increases gradually during adulthood. Weight and body mass index (BMI) peak between 50 and 59 years, then stabilize and start slowly dropping around age 70.[7,31] Reasons for age-associated gains are uncertain, but longitudinal studies are showing that decreased physical activity and lower metabolism could be factors.[32] For example, men in the Baltimore Longitudinal Study on Aging decreased their energy expenditure by 17–24 calories per day after age 55, and gained weight.[33] In the Fels Longitudinal Study, men gained 0.7 pounds per year, and women gained an average of 1.2 pounds as they aged.[28] Subjects were 40–66 years old when entering the study and were followed for up to 20 years. Weight gains were concurrent with decreases in lean body mass and increases in body fat. This overall weight and body-composition shift was moderated by physical activity. For example, the two groups with

functional status Ability to perform daily activities to meet basic needs and live independently, including telephoning, grocery shopping, food preparation, and eating.

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moderate or high physical activity levels (as opposed to the least active group) increased lean body mass and decreased total and percentage of body fat as age increased. Physical activity effects differed by sex. In women, higher levels of physical activity were associated with higher levels of lean body mass. However, lack of estrogen seems to promote fat accumulation, and total weight increased regardless of the group's activity level. Men in the highest physical activity groups in the Fels Longitudinal Study slowed their total body-weight and body-fat gains.

Changing Sensual Awareness: Taste and Smell, Chewing and Swallowing, Appetite and Thirst

Taste and Smell Although there is some argument about the extent to which aging affects the sense of taste, there is general agreement that taste and smell senses are generally robust until age 60, when they start declining. Approximately 75 percent of individuals over age 80 have some olfactory impairment, compared to 6 percent of adults in their fifties.[34,35] Women retain their sense of smell better than men do. Other than aging (Table 18.3), conditions leading to impaired olfaction include congestion, upper respiratory tract infections, stroke, epilepsy, medications, and current smoking.

Eating is a sensuous activity, involving not just taste buds but also the olfactory nerves and, many believe, the eyes. A blunted sense of smell can lead to blunted enjoyment of food, which anyone with a stuffy nose can easily affirm. Declining taste and smell also result in decreased ability to detect spoiled or burnt foods.

It is difficult to sort out whether aspects of sensory decline are due to illness or age. The number and structure of taste buds are not significantly altered during aging. In addition, taste perception for sucrose does not decline with age. Taste has been so important to biological survival that the body developed redundant systems. Several pathways of nerves and receptors control taste mechanisms. All of the pathways would have to be damaged before the ability to identify tastes is lost.

Disease, medications, and covering part of the palate with dentures may affect taste more than does age itself. Yet age matters. For example, during illness or with the use of medications, younger individuals maintained greater ability than older individuals to detect salty, bitter, sour, sweet, and savory tastes.[36]

Oral Health: Chewing and Swallowing Poor dietary habits are a modifiable risk factor that can contribute to caries and potential tooth loss. Approximately 19 percent of adults aged 65 and over had no natural teeth (edentulous) in 2011–2012. Edentulism was twice as prevalent in adults aged 75 and over than in those 65–74 years and higher among adults with chronic conditions. Tooth loss has declined over the years, although this statistic varies greatly by income, education level, state and health condition.[37] Tooth loss is associated with poor nutritional status,[38] disability, and mortality in old age or may be a potential risk marker for all-cause mortality.[39] What and when we eat affects oral health. Oral health affects what we eat and, in turn, nutritional status and health. Oral health depends on several organ systems working together: gastrointestinal secretions (saliva), the skeletal system (teeth and jaw), mucous membranes, muscles (tongue, jaw), taste buds, and olfactory nerves for smelling and tasting. Disturbances in oral health and tooth loss are associated with, but not necessarily caused by, aging.

Healthy teeth are protected by an enamel layer, but bacterial action on the breakdown products of food slowly erodes tooth enamel. For about 15 minutes after we ingest food or drink, oral bacteria feast on the food breakdown products, especially those of sucrose. Foods such as caramels or raisins stick around longer, especially when they lodge between teeth. Frequent eating and drinking of sugary beverages provides a continuous substrate for bacteria. The acid in carbonated beverages adds to the corrosive potential of food. In addition, poor oral hygiene and a diet deficient in vitamin C and in zinc contribute to periodontal disease.[40]

Saliva, which lubricates the mouth and begins the digestive process (amylase in "spit" begins starch breakdown), also helps to keep tooth enamel clean. However, saliva seems to become thicker and more viscous with age. Lack of saliva slows nutrient absorption. Lack of sufficient and effective saliva, especially in the presence of gingivitis and periodontal disease, also makes the oral cavity more sensitive to temperature extremes and coarse textures, resulting in pain while eating. Keeping the oral cavity moist through frequent sips of water and artificial saliva is beneficial.

Pain and discomfort with chewing foods can result in eating fewer fruits, vegetables, and whole grains. A loss of self-esteem associated with missing teeth and worry regarding how to pay for dental care can affect quality of life. Edentulous (no natural teeth) older people are less likely to visit the dentist for oral care (denture adjustment, periodontal disease management) than are those individuals having their natural teeth.

An oral health assessment is particularly important for older adults because they are more likely to have conditions that exacerbate periodontal disease. It includes review of soft tissues, teeth, and other factors that may affect dietary intake. One such factor is functional status, which can affect the ability to brush, floss, and obtain regular dental care, potentially resulting in periodontal disease, which can precipitate tooth loss and lead to a vicious cycle.

Appetite and Thirst Hunger and satiety cues are weaker in older than in younger adults. Roberts and colleagues examined the ability of 17 young men (mean age 24) and 18 older men (mean age 70) to adjust caloric intake after periods of overeating and of undereating.[41] All men were healthy and not taking medications. Food intake and weight were monitored for 10 days, and then men were

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overfed by roughly 1,000 calories, or underfed by about 800 calories, for 21 days. Periods of over- or underfeeding were followed by 46 days of "ad lib" intake during which all men were free to eat as much or as little as desired. After the periods of over- and underfeeding, young men adjusted their caloric intake to get back to their initial calorie intake level and weight. Older men kept overeating if they had been in the overfed group, and undereating if they had been in the underfed group. The authors suggest that older adults may need to be more conscious of food intake levels because their appetite-regulating mechanism may be blunted. Whereas healthy young people adjust to cycles of more and less food intake, healthy older people's inability to adapt to these changes may lead to overweight or anorexia.

Older adults don't seem to notice thirst as clearly as younger people do. A set of papers by Phillips and Rolls demonstrated that the thirst-regulating mechanism of older adults was less effective than that of younger individuals.[42–44] Researchers compared thirst response to fluid deprivation in a group of seven 20- to 31-year-old men, and seven 67- to 75-year-old men. Subjects lost 1.8–1.9 percent of body weight during 24 hours without fluids. Both groups were asked about feeling thirsty, mouth dryness, and how pleasant it would be to drink something. After fluid deprivation, the younger group reported being thirsty and having a dry mouth. The older group, however, reported no change in thirst or mouth dryness. Both the older and younger groups thought that it would be pleasant to drink something after fluid deprivation. Blood measures showed that older men lost more blood volume than younger men did, indicated by their plasma concentrations of sodium. Researchers also measured how much water the men drank in the hour after their 24-hour period of fluid deprivation. Older men drank less water than their younger counterparts did. Younger people made up for fluid loss in 24 hours; older people did not drink enough to achieve their prior state of hydration. It appears that dehydration occurs more quickly after fluid deprivation and that rehydration is less effective because of lower thirst sensation and reduced renal water-conservation capacity. The prevalence of water-loss dehydration is estimated to be 20–30 percent in the older adult population.[45]

18.4 Nutritional Risk Factors

Identifying nutritional risk factors before chronic illness occurs is basic to health promotion. Risk-factor reduction forms the basis of dietary guidance. In adults of all ages, dietary risk factors that increase the likelihood of developing heart disease, cancer, diabetes, and stroke are consuming a diet that is high in saturated fat; low intake of vegetables, fruits, and whole-grain products; and poor nutritional habits leading to obesity. Healthy People 2030, the Dietary Guidelines for Americans, and MyPlate graphics all emphasize eating patterns designed to reduce the risk of the leading killer diseases.

Identifying risk factors potentially leading to malnutrition can also be done by comparing dietary intake to nutrient intake recommendations such as the Dietary Reference Intakes. For example, sodium is a risk factor for hypertension, which is a problem for many older adults. How many of them limit sodium to amounts that would reduce their high blood pressure? More women aged 51 and over (35 percent) than men (16 percent) stay below 2300 mg per day, but this is due to a lower caloric intake.[46] High sodium intake is a nutrition risk factor that is amenable to prevention efforts.

Another approach is to screen a population for risk factors that lend themselves to interventions to prevent or delay the onset of chronic conditions or prevent further deterioration of health. Several screening tools are available, such as the Nutrition Screening Initiative (NSI), the Mini Nutritional Assessment (MNA), and the Malnutrition Universal Screening Tool (MUST). Each of the tools has advantages and limitations, and the choice of which one to use is dependent on the objective of the screening and the resources available.

The NSI is the first nutrition screening tool developed and was based on the accumulating evidence that nutritional risk factors affect the health status of individuals. The American Academy of Family Physicians, the Academy of Nutrition and Dietetics, and the National Council on the Aging sponsored the development of this screening and assessment tools. A consortium of care providers, policy makers, and researchers used literature review, expert discussion, and a consensus process to generate a list of warning signs of poor nutritional health in older adults.[47,48] These warning signs were integrated into a screening tool, the NSI DETERMINE checklist (Table 18.5 and Figure 18.2), and pilot-tested for use in community settings. Ten risk factors remained after testing a longer list.[49] This tool is freely available for use and many community agencies, educators, and care providers have integrated parts or all of NSI tools into their own materials to screen for nutrition risk factors.

The nutritional risk factors identified during the NSI process[48] are reflected in the list of risk factors identified in the Academy of Nutrition and Dietetics' position on nutrition and aging.[3] Any of the following conditions potentially place older adults at nutritional risk:

- Hunger
- Poverty
- Inadequate food and nutrient intake
- Functional disability
- Social isolation
- Living alone

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Table 18.5 DETERMINE: Warning signs of poor nutritional health

Disease. Any disease, illness, or chronic condition (i.e., confusion, feeling sad or depressed, acute infections) that causes changes in the way you eat, or makes it hard for you to eat, puts your nutritional health at risk.
Eating poorly. Eating too little, too much, or the same foods day after day, or not eating fruits, vegetables, and milk products daily, will cause poor nutritional health.
Tooth loss/mouth pain. It is hard to eat well with missing, loose, or rotten teeth, or dentures that do not fit well or cause mouth sores.
Economic hardship. Having less or choosing to spend less than $52.80 (female) to $54.30 (male) weekly for groceries makes it hard to get the foods needed to stay healthy. (These costs are calculated for individuals living in four-person households; 20 percent will be added to adjust for living alone. All meals and snacks are prepared at home.)
Reduced social contact. Being with people has a positive effect on morale, well-being, and eating.
Multiple medicines. The more medicines you take, the greater the chance for side effects such as change in taste, increased or decreased appetite and thirst, constipation, weakness, drowsiness, diarrhea, nausea, and others. Vitamins or minerals taken in large doses can act like drugs and can cause harm.
Involuntary weight loss or gain. Losing or gaining a lot of weight when you are not trying to do so is a warning sign to discuss with your health-care provider.
Needs assistance in self-care. Older people who have trouble walking, shopping, and buying and cooking food are at risk for malnutrition.
Elder years above 80. As age increases, risk of frailty and health problems also rises.

Sources: Warning signs adapted from Nutrition Screening Initiative, a project of the American Academy of Family Physicians, the American Dietetic Association (Academy of Nutrition and Dietetics), and the National Council on the Aging, Inc., and funded by a grant from Ross Products Division, Abbott Laboratories, Inc.; dollar amounts under economic hardship inserted by author using the March 2022 USDA Thrifty Food Plan (https://www.fns.usda.gov/cnpp/usda-food-plans-cost-food-reports-monthly-reports).

- Urban and rural demographic areas
- Depression
- Dementia
- Dependency
- Poor dentition and oral health; chewing and swallowing problems
- Presence of diet-related acute or chronic diseases or conditions
- Polypharmacy (use of multiple medications)
- Minority status
- Advanced age

Why are factors such as poverty and minority status included in a list of nutritional risk factors? Although older people on average are less likely to live in poverty than are children, several subpopulations of older adults are at high risk of poverty (Table 18.6). Economic security contributes to food security. Lack of food security in older adults is associated with inadequate food intakes, especially for energy, protein, and several micronutrients.[50,51] Race/ethnicity is related to economic status; older Black people are about twice as likely as non-Hispanic White older adults to live in low-income households and are also more likely to be food-insecure.[52] Black and Hispanic populations aged 65 and over are more likely to be poor or nearly poor (living at or below 199 percent of the poverty guideline). Furthermore, underserved populations are more likely to be in fair or poor health, while non-Hispanic White people are most likely to be in excellent or good health. Similarly, women live longer than men, have more disabilities, and a larger population live below the poverty line. Health-care costs may contribute to food insecurity; for some, that means choosing between drugs and food.

Poverty is one risk factor for malnutrition; polypharmacy is another. Prescription drug use increases with age; 85 percent of adults aged 60 and over used prescription drugs in the previous month in 2015–2016.[53] Prescription drug use did not vary significantly by sex, race and Hispanic-origin groups. Between prescription drugs, vitamin and mineral supplements, and over-the-counter (OTC) products, it is not uncommon for someone to take 10 pills a day. Such use of multiple medications invites adverse drug events from potentially inappropriate drugs and from drug–drug interactions. Health-care expenditures related to the use of potentially inappropriate drugs are estimated to be over $7 billion annually.[54] The most commonly used medications of older adults were lipid-lowering drugs.

Taken individually, the risk factors identified in the DETERMINE acronym are not unique to older adults. But each is more likely to lead to nutritional problems in a frail, vulnerable population. For instance, functional disability can affect dietary intake at any age, but very old people are more likely to live alone and to have fewer resources to compensate for lost function. Consequently, diet quality may decline. Fewer 65-year-olds live alone than 75- and 85-year-olds, and more women than men live alone. Race and ethnicity affect living situations; Hispanic and Asian men and women aged 65 and over are least likely to live alone, whereas non-Hispanic White and Black women are most likely to live alone. A common perception is that older adults living alone eat poorly. Although living alone is a nutritional risk factor, it's not clear whether the issue is eating alone, living alone, or lack of social contact.[55] On average, meals eaten with other people last longer and supply more calories than do meals eaten alone.[56] The effect of living alone

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The warning signs of poor nutritional health are often overlooked. Use this checklist to find out if you or someone you know is at nutritional risk.

Read the statements below. Circle the number in the yes column for those that apply to you or someone you know. For each yes answer, score the number in the box. Total your nutritional score.

Determine Your Nutritional Health

	YES
I have an illness or condition that made me change the kind and /or amount of food I eat.	2
I eat fewer than two meals per day.	3
I eat few fruits or vegetables, or milk products.	2
I have three or more drinks of beer, liquor or wine almost every day.	2
I have tooth or mouth problems that make it hard for me to eat.	2
I don't always have enough money to buy the food I need.	4
I eat alone most of the time.	1
I take three or more different prescribed or over-the-counter drugs a day.	1
Without wanting to, I have lost or gained 10 pounds in the last six months.	2
I am not always physically able to shop, cook and/or feed myself.	2
TOTAL	

Total your nutritional score. If it's --

0-2 **Good!** Recheck your nutritional score in 6 months.

3-5 **You are at moderate nutritional risk.** See what can be done to improve your eating habits and lifestyle. Your office on aging, senior nutrition program, senior citizens center or health department can help. Recheck your nutritional score in 3 months.

6 or more **You are at high nutritional risk.** Bring this checklist the next time you see your doctor, dietitian or other qualified health or social service professional. Talk with them about any problems you may have. Ask for help to improve your nutritional health.

Remember that warning signs suggest risk, but do not represent diagnosis of any condition. Turn the page to learn more about the Warning Signs of poor nutritional health.

The Nutrition Checklist is based on the warning signs described below. Use the word DETERMINE to remind you of the warning signs.

Disease
Any disease, illness or chronic condition that causes you to change the way you eat, or makes it hard for you to eat, puts your nutritional health at risk. Four out of five adults have chronic diseases that are affected by diet. Confusion or memory loss that keeps getting worse is estimated to affect one out of five or more of older adults. This can make it hard to remember what, when or if you've eaten. Feeling sad or depressed, which happens to about one in eight older adults, can cause big changes in appetite, digestion, energy level, weight and well-being.

Eating Poorly
Eating too little and eating too much both lead to poor health. Eating the same foods day after day or not eating fruit, vegetables and milk products daily will also cause poor nutritional health. One in five adults skips meals daily. Only 13 percent of adults eat the minimum amount of fruits and vegetables needed. One in four older adults drinks too much alcohol. Many health problems become worse if you drink more than one or two alcoholic beverages per day.

Tooth Loss/Mouth Pain
A healthy mouth, teeth and gums are needed to eat. Missing, loose or rotten teeth or dentures which don't fit well or cause mouth sores make it hard to eat.

Economic Hardship
As many as 40 percent of older Americans have incomes of less than $6,000 per year. Having less--or choosing to spend less--than $25 to $30 per week for food makes it very hard to get the foods you need to stay healthy.

Reduced Social Contact
One-third of all older people live alone. Being with people daily has a positive effect on morale, well-being and eating.

Multiple Medicines
Many older Americans must take medicines for health problems. Almost one half of older Americans take multiple medicines daily. Growing old may change the way we respond to drugs. The more medicines you take, the greater the chance for side effects such as increased or decreased appetite, change in taste, constipation, weakness, drowsiness, diarrhea, nausea and others. Vitamins or minerals when taken in large doses act like drugs and can cause harm. Alert your doctor to everything you take.

Involuntary Weight Loss/Gain
Losing or gaining a lot of weight when you are not trying to do so is an important warning sign that must not be ignored. Being overweight or underweight also increases your chance of poor health.

Needs Assistance in Self Care
Although most older people are able to eat, one of every five has trouble walking, shopping, buying and cooking food, especially as they get older.

Elder Years Above Age 80
Most older people lead full and productive lives. But as age increases, risk of frailty and health problems increase. Checking you nutritional health regularly makes good sense.

The Nutrition Screening Initiative • 1010 Wisconsin Avenue, NW • Suite 800 • Washington, DC 20007
The Nutrition Screening Initiative is funded in part by a grant from Ross Products Division of Abbott Laboratories, Inc.

Figure 18.2 Determine your nutritional health checklist.

Sources: The Nutrition Screening Initiative, originated as a project of the American Academy of Family Physicians, The American Dietetic Association and the National Council on the Aging, Inc., with funding by a grant from Ross Products Division, Abbott Laboratories, Inc.; screening questions have been adopted by state agencies and private healthcare companies. https://acl.gov/sites/default/files/nutrition/NSI_checklist_508%20with%20citation.pdf, accessed May 9,2022.

Table 18.6 By the numbers: Food budgets and poverty statistics

Food Budget for 1 Year, Based on USDA's Low-Cost Food Plan (December 2021 Figures)	
Female aged 71 and older: $3,345 ($53.6/week plus 20% for single household)	
Male, aged 71 and older: $3,3,713 ($59.5/week plus 20% for single household)	
Median Income for a person aged 65+ (2019):	$27,398
Defining Poverty:	
2022 Poverty Guidelines (Health and Human Services) for a one-person household (any age)	
For the 48 contiguous states and the District of Columbia	$13,590
For Hawai'i	$15,630
For Alaska	$16,990
By race, poverty statistics for adults aged 65 and older:	
Percent living below the poverty level (2019)	
All races	9.4%
White	6.8%
Asian	9.3%
Hispanic	17.1%
Black	18.0%
For reference, during this same time period, 16.8% of children under age 18 lived below the poverty level.	
By geography: the fewest low-income older adults live in the Northeast, the most in the South.	
Takeaway: A 71-year-old female, living alone in one of the 48 contiguous states, would spend about 27% of her income on food to meet nutritional needs if all food is prepared at home. She has $62.2 per week to meet her nutritional needs; every bite counts when you are living in poverty and 27% of your income goes for food. U.S. households with higher incomes spend more money on food, but the amount spent represents a smaller overall portion of their budgets. In 2020, U.S. consumers spent an average of 8.6% of their disposable personal income on food.	

Sources: https://www.fns.usda.gov/cnpp/usda-food-plans-cost-food-reports-monthly-reports, accessed May 10, 2022; https://www.pensionrights.org/resource/income-of-todays-older-adults/, accessed May 10, 2022; https://aspe.hhs.gov/topics/poverty-economic-mobility/poverty-guidelines, accessed May 10, 2022; and https://sgp.fas.org/crs/misc/R45791.pdf, accessed May 10, 2022.

starts at a younger age for men and affects nutrition more extensively than for women.[57] The purpose of a screening tool is primary prevention. Screening for nutritional risk should identify conditions that need further exploration, such as detecting significant weight loss. The NSI DETERMINE tool includes a cumulative score. The score was shown to weakly predict mortality in an aging population of mostly White, educated adults[58] and did not consistently identify all those individuals who had poor health or low nutrient consumption.[49] Therefore, although the NSI scoring system is not necessarily useful in identifying existing malnutrition, its individual questions address common risk factors that could potentially lead to interventions to prevent malnutrition. The advantage of this screener is that it alerts older adults and caregivers of potential nutritional risk factors. This tool is a mandatory requirement for screening older adults who participate in the federally funded home-delivered meal program.

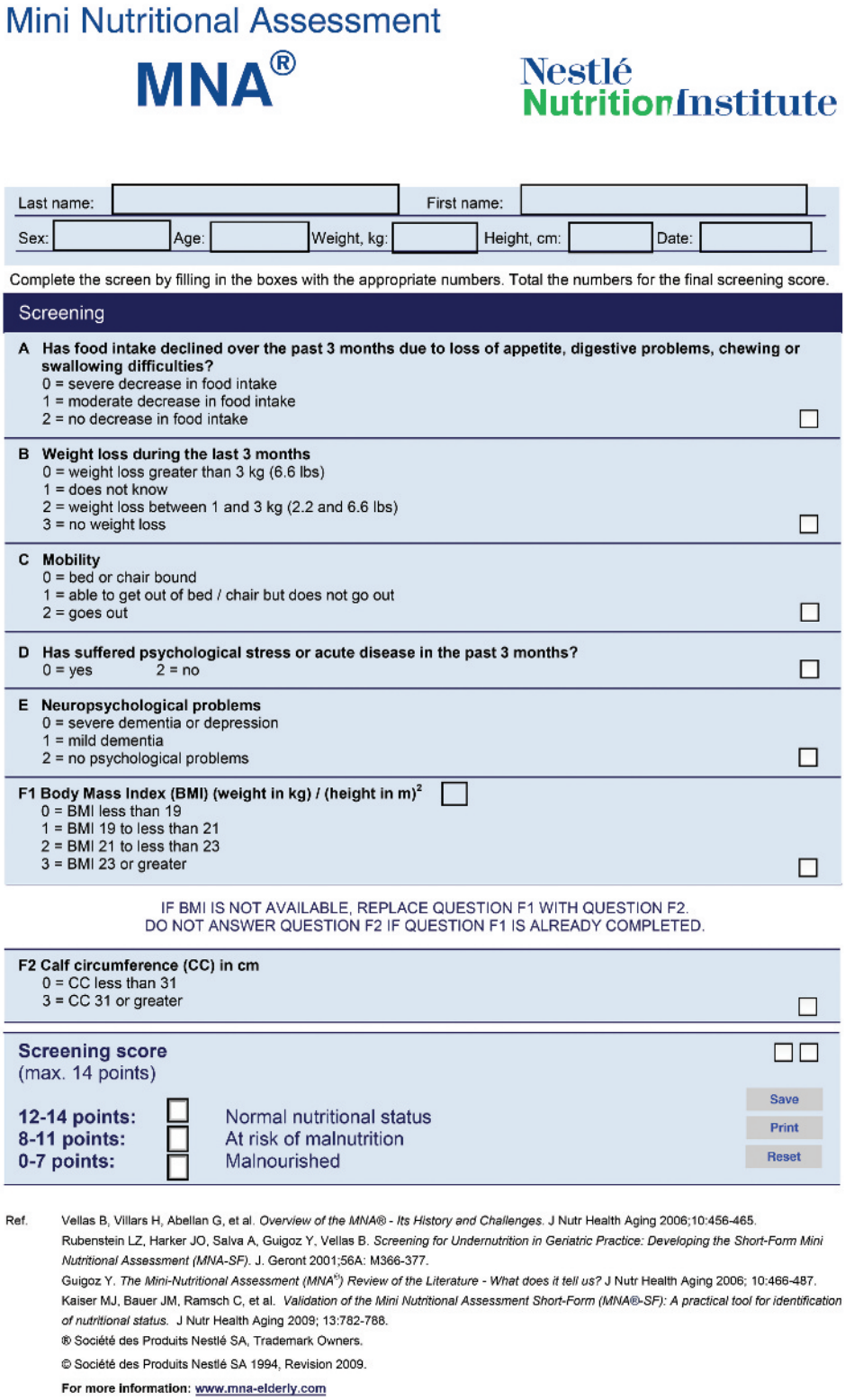
The MNA short form uses six screening items, including BMI, to identify individuals at risk of malnutrition (Figure 18.3). It replaces a longer 18-item form available for screening and assessment, and does not require blood work or other biochemical tests, unlike hospital-based screening tools.[59] MNA has been used in clinical, home-care, and community settings. Note that the MNA uses a BMI of 23 or greater as presenting the least risk of malnutrition in older adults. The MNA is an easy to use, validated tool that identifies individuals at risk of malnutrition.

The Malnutrition Universal Screening Tool (MUST) is another brief tool that was developed for institutional and community use to identify adults who are malnourished or at risk of malnutrition.[60] Assessment of nutritional status is a five-step process:

1. Use height and weight measurement to calculate BMI.
2. Score unplanned weight loss.
3. Assign an acute disease effect score (e.g., no nutritional intake due to illness for more than 5 days rates the maximum risk score of 2).
4. Sum scores to determine overall risk of malnutrition.
5. Use the score to plan management.

When height and weight cannot be measured, alternative calculations using the ulna or self-reported height are suggested. The focus of scoring the MUST tool is to

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Mini Nutritional Assessment

MNA®

Nestlé Nutrition Institute

Last name: First name:

Sex: Age: Weight, kg: Height, cm: Date:

Complete the screen by filling in the boxes with the appropriate numbers. Total the numbers for the final screening score.

Screening

A Has food intake declined over the past 3 months due to loss of appetite, digestive problems, chewing or swallowing difficulties?
0 = severe decrease in food intake
1 = moderate decrease in food intake
2 = no decrease in food intake

B Weight loss during the last 3 months
0 = weight loss greater than 3 kg (6.6 lbs)
1 = does not know
2 = weight loss between 1 and 3 kg (2.2 and 6.6 lbs)
3 = no weight loss

C Mobility
0 = bed or chair bound
1 = able to get out of bed / chair but does not go out
2 = goes out

D Has suffered psychological stress or acute disease in the past 3 months?
0 = yes 2 = no

E Neuropsychological problems
0 = severe dementia or depression
1 = mild dementia
2 = no psychological problems

F1 Body Mass Index (BMI) (weight in kg) / (height in m)²
0 = BMI less than 19
1 = BMI 19 to less than 21
2 = BMI 21 to less than 23
3 = BMI 23 or greater

IF BMI IS NOT AVAILABLE, REPLACE QUESTION F1 WITH QUESTION F2.
DO NOT ANSWER QUESTION F2 IF QUESTION F1 IS ALREADY COMPLETED.

F2 Calf circumference (CC) in cm
0 = CC less than 31
3 = CC 31 or greater

Screening score
(max. 14 points)

12-14 points: Normal nutritional status
8-11 points: At risk of malnutrition
0-7 points: Malnourished

Save Print Reset

Ref. Vellas B, Villars H, Abellan G, et al. *Overview of the MNA® - Its History and Challenges*. J Nutr Health Aging 2006;10:456-465.
Rubenstein LZ, Harker JO, Salva A, Guigoz Y, Vellas B. *Screening for Undernutrition in Geriatric Practice: Developing the Short-Form Mini Nutritional Assessment (MNA-SF)*. J. Geront 2001;56A: M366-377.
Guigoz Y. *The Mini-Nutritional Assessment (MNA®) Review of the Literature - What does it tell us?* J Nutr Health Aging 2006; 10:466-487.
Kaiser MJ, Bauer JM, Ramsch C, et al. *Validation of the Mini Nutritional Assessment Short-Form (MNA®-SF): A practical tool for identification of nutritional status.* J Nutr Health Aging 2009; 13:782-788.

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For more information: www.mna-elderly.com

Figure 18.3 MNA nutritional screening and assessment.
Source: https://www.mna-elderly.com/sites/default/files/2021-10/mna-mini-english.pdf, accessed May 9, 2022.

predict ability to combat disease; MUST uses a BMI of 20 or less to flag potential malnutrition. A BMI of 30 or more is scored as *obese*. MUST is the most commonly used screening tool in the United Kingdom and is validated. It is most applicable to frail older adults. Several other screening tools are available; however, the best tool to use is dependent on the purpose for the screening and the options available for follow-up.[61]

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18.5 Dietary Recommendations for Older Adults

In all discussions about nutritional effects on health and disease status of older adults, we forget that old age is not a disease. No matter what the health status of a person is, however, recommendations for specific nutrients change with age, and food consumption patterns need to adjust accordingly. For the first time, the USDA and HHS Dietary Guidelines for Americans 2020–2025 took a life-span approach from birth through older adulthood with a chapter dedicated to older adults.[62] This chapter emphasizes the importance of making nutrient dense, healthy food and beverage choices because older adults have lower calorie needs but similar or higher nutrient needs. As age increases from younger adulthood to older age, the number of calories required are reduced due to several reasons including a decrease in physical activity and changes in metabolism. Females ages 60 and older require about 1,600 to 2,000 calories per day and males about 2,000 to 2,600 calories per day, depending on age and activity level (Table 18.7). The Dietary Guidelines for Americans 2020–2025 provides a recommended healthy dietary pattern for this age group by calorie levels (Table 18.7).

The educational component of the Dietary Guidelines is a plate icon known as MyPlate. The USDA MyPlate is available for all age groups, including older adults (https://www.myplate.gov/life-stages/older-adults). The MyPlate website offers information on unique needs of individuals

Table 18.7 Healthy U.S.–style dietary pattern for adults ages 60 and older, with daily or weekly amounts from food groups, subgroups, and components

CALORIE LEVEL OF PATTERN[a]	1,600	1,800	2,000	2,200	2,400	2,600
FOOD GROUP OR SUBGROUP[b]	Daily Amount of Food from Each Group (Vegetable and protein foods subgroup amounts are per week.)					
Vegetables (cup eq/day)	**2**	**2½**	**2½**	**3**	**3**	**3½**
	Vegetable Subgroups in Weekly Amounts					
Dark-Green Vegetables (cup eq/wk)	1½	1½	1½	2	2	2½
Red and Orange Vegetables (cup eq/wk)	4	5½	5½	6	6	7
Beans, Peas, Lentils (cup eq/wk)	1	1½	1½	2	2	2½
Starchy Vegetables (cup eq/wk)	4	5	5	6	6	7
Other Vegetables (cup eq/wk)	3½	4	4	5	5	5½
Fruits (cup eq/day)	**1½**	**1½**	**2**	**2**	**2**	**2**
Grains (ounce eq/day)	**5**	**6**	**6**	**7**	**8**	**9**
Whole Grains (ounce eq/day)	3	3	3	3½	4	4½
Refined Grains (ounce eq/day)	2	3	3	3½	4	4½
Dairy (cup eq/day)	**3**	**3**	**3**	**3**	**3**	**3**
Protein Foods (ounce eq/day)	**5**	**5**	**5½**	**6**	**6½**	**6½**
	Protein Foods Subgroups in Weekly Amounts					
Meats, Poultry, Eggs (ounce eq/wk)	23	23	26	28	31	31
Seafood (ounce eq/wk)	8	8	9	9	10	10
Nuts, Seeds, Soy Products (ounce eq/wk)	4	4	5	5	5	5
Oils (grams/day)	**22**	**24**	**27**	**29**	**31**	**34**
Limit on Calories for Other Uses (kcal/day)[c]	**100**	**140**	**240**	**250**	**320**	**350**
Limit on Calories for Other Uses (%/day)	8%	8%	12%	11%	12%	12%

[a] Calorie level ranges: Females: 1,600-2,200 calories; Males: 2,000-2,600 calories. Energy levels are calculated based on median height and body weight for healthy body mass index (BMI) reference individuals. For adults, the reference man is 5 feet 10 inches tall and weighs 154 pounds. The reference woman is 5 feet 4 inches tall and weighs 126 pounds. Calorie needs vary based on many factors. The DRI Calculator for Healthcare Professionals, available at nal.usda.gov/fnic/dri-calculator, can be used to estimate calorie needs based on age, sex, height, weight, and physical activity level.

[b] Definitions for each food group and subgroup and quantity (e.g., cup or ounce equivalents) are provided in *Chapter 1* and are compiled in *Appendix 3*.

[c] All foods are assumed to be in nutrient-dense forms; lean or low-fat and prepared with minimal added sugars; refined starches, saturated fat, or sodium. If all food choices to meet food group recommendations are in nutrient-dense forms, a small number of calories remain within the overall limit of the pattern (i.e., limit on calories for other uses). The number of calories depends on the total calorie level of the pattern and the amounts of food from each food group required to meet nutritional goals. Calories up to the specified limit can be used for added sugars, saturated fat, and/or alcohol, or to eat more than the recommended amount of food in a food group.

*Note: The total dietary pattern should not exceed *Dietary Guidelines* limits for added sugars, saturated fat, and alcohol; be within the Acceptable Macronutrient Distribution Ranges for protein, carbohydrate, and total fats; and stay within calorie limits. Values are rounded. Refer to *Appendix 3* for USDA Dietary Patterns.

Source: *Dietary Guidelines for Americans, 2020–2025*.[62]

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ages 60 and over, nutrition tips, physical activity, and resources. The resources include an app to help people make informed, healthy food choices. Calorie levels can be modified by choosing more or less nutrient-dense foods from each food group. For instance, citrus and berries are among the most nutrient-dense fruits. A baked potato has more vitamins and minerals per calorie than French fries. Among grain-based products, whole-grain breads and cereals provide fiber as well as the usual nutrients found in grain. Consistently choosing nutrient-dense foods minimizes caloric intake. With the increase in food fortification, it is sometimes hard to know whether to count an item as food or supplement. For instance, adequate folic acid intake was problematic before 1998, when folic acid fortification of grain products became mandatory. Now, older adults consume more than enough folic acid and could easily exceed the 1,000 mcg Tolerable Upper Intake Level (UL) if they take supplements.

Calorie requirements of older adults are reduced with age so that there is little room for added sugars, saturated fat, sodium, or alcoholic beverages. Therefore, the Dietary Guidelines for Americans' recommendation is to choose nutrient-dense foods with little to no added sugar, saturated fats, or sodium. However, a study using NHANES data showed that about 93 percent of the older population consumed snacks. These snacks provided between 17 and 21 percent of their daily energy intake with a range of 27 to 33 percent sugar.[63] But, snacks can contribute to more than fat and sugar and could serve as a complementary source of nutrients that may be missed at other meals.

What are some of the specific nutrients that will enhance the nutritional status of older adults? Read on.

18.6 Nutrient Recommendations

Nutrient recommendations change as scientists learn more about the effect of foods on human lives. Before 1997, nutrient recommendations for older adults were for the combined age group of 51 and over; however, nutrient levels specific for population groups ages 51–70 and 71+ were first established in 1997 as the DRIs were also first introduced. The complete tables, including UL, are found on the inside covers of this text. This section addresses current intakes and energy recommendations (Tables 18.8–18.10), followed by vitamin and mineral intakes (Table 18.11).[64-66]

Estimating Energy Needs

The main goal for energy calculations is to maintain a healthy body weight. Total energy expenditure is primarily determined from resting energy expenditure, which slows with age, thermic effect of food, and physical activity which is highly variable among individuals. However, genetics, hormones, and body composition also influence metabolic rates, resulting in broad ranges of energy needs for older populations. NHANES data shows caloric intake decrease as adults age.[64] Women aged 70 and older report the lowest intake and may be especially vulnerable to malnutrition, even though the prevalence of obesity is high (BMI = 30 or more).

Estimated Energy Requirement (EER) is the average dietary energy intake that is predicted to maintain energy balance in individuals of a certain age, gender, weight, height, and level of physical activity.[66] Traditionally, the Harris-Benedict formula, the Mifflin-St. Jeor formula, and others[67-69] have been used primarily in clinical settings to estimate individual resting energy expenditure. However, they all had some limitations such as lack of validation on older adult populations or difficulty of use. Recently, the U.S. and Canadian governments requested from the National Academies of Sciences, Engineering and Medicine to convene an expert committee to update the EER of its populations. Since the prior update of energy requirements in 2002/2005, a large number of evidences became available including several Doubly Labelled Water (DLW) datasets. DLW, which uses stable isotopes to measure energy expenditure, is considered the gold standard to assess energy expenditure. In 2023, the National Academies released the EER predictive equations.[66] These equations are based on age, sex, weight, height, and level of physical activity (Table 18.8). The physical activity categories were defined as inactive, low active, active, and very active. The inactive category reflects minimal level of physical activity that is required for activities of daily living and the low active, active and very active physical activity reflect increasing levels of physical activity. The equations may be used to calculate the EER of individuals and groups. However, it is more complicated to calculate the calories for a group of people as caloric needs vary. The recommendation is to use the mean or median values for height, weight and age of group members to calculate the EER. Table 18.9 provides the EER for U.S. Population of Adult Men and Women age groups 51–70 and 70+, based on Median Height and Weight obtained from the NHANES normative data.[66]

Nutrient Recommendations for Older Adults: Energy Sources

Some nutrients are potentially problematic for older adults to consume in adequate amounts. The nutrients listed in Tables 18.10 and 18.11 are compared to the EAR and AI (when applicable). The following nutrients are most often potentially problematic for older adult populations.

Carbohydrate and Fiber Carbohydrate intake between 45 and 65 percent of calories (the acceptable macronutrient distribution range, AMDR) is generally not a problem.[65] However, older adults could improve the nutrient density of their carbohydrate intake by

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Table 18.8 Estimated Energy Requirements (EER) equations by age, sex, and physical activity in adults 19 years and above with sample calculation

Age Group	Sex	PAL Category	EER Equation (kcal/d)
19+ years	M	Inactive	753.07 − (10.83 × age) + (6.50 × height) + (14.10 × weight)
		Low active	581.47 − (10.83 × age) + (8.30 × height) + (14.94 × weight)
		Active	1,004.82 − (10.83 × age) + (6.52 × height) + (15.91 × weight)
		Very active	517.88 − (10.83 × age) + (15.61 × height) + (19.11 × weight)
	F	Inactive	584.90 − (7.01 × age) + (5.72 × height) + (11.71 × weight)
		Low active	575.77 − (7.01 × age) + (6.60 × height) + (12.14 × weight)
		Active	710.25 − (7.01 × age) + (6.54 × height) + (12.34 × weight)
		Very active	511.83 − (7.01 × age) + (9.07 × height) + (12.56 × weight)

kcal/d = kilocalories per day; PAL = physical activity level and reflect increasing levels of activity; EER = Estimated Energy Requirement; Age is in years, height is in centimeters and weight is in kilograms.

Source: National Academies of Sciences, Engineering, and Medicine. 2023.

Example: 70-year-old woman who is 5 feet 3 inches (160.02 centimeters, weighs 147 pounds (66.7 kilograms), and is low active:

EER = 575.77 − (7.01 × 70) + (6.60 × 160.02) + (12.14 × 66.7)

= 575.8 − 490.7 + 1,056.1 + 809.7

= 1,951 kcal/day

eating more fiber-rich food. Following the MyPlate recommendations ensures that the carbohydrate quantity and quality is adequate and that fiber guidelines are met. For example, individuals who need 2,000 calories/day would need to eat 250 grams of carbohydrate per day to meet 50 percent of calories from carbohydrate sources (Table 18.12). Selecting whole grains and vegetables brings dietary fiber levels closer to recommended levels (14 grams/1,000 calories) (Table 18.13). These foods would also help to raise nutrients that are underconsumed, such as magnesium and vitamin E. Dietary fiber reduces the risk of coronary heart disease, but older adults are more often concerned with the role of fiber for gastrointestinal health; this is discussed in Chapter 19. A slow increase of dietary fiber allows intestinal microflora to adapt to added substrate.

Table 18.9 Estimated Energy Requirements (EER) for U.S. population of adult men and women, based on median height and weight for age group

	Median Height and Weight[a]				EER (kcal/d)[b]			
Age Group[c] (y)	Height (cm)	Height (in)	Weight (kg)	Weight (lb)	Inactive PAL[d]	Low active PAL	Active PAL	Very active PAL
Men								
51–70	174.9	68.9	88.7	195.1	2,491	2,709	2,907	3,258
>70	172.2	67.8	83.3	183.3	2,181	2,389	2,586	2,896
19+	175.4	69.1	87.2	191.8	2,581	2,799	2,994	3,345
Women								
51–70	160.8	63.3	74.8	164.6	1,960	2,125	2,264	2,489
>70	156.8	61.7	69.7	153.3	1,737	1,896	2,035	2,249
19+	161.2	63.5	73.2	161.0	2,014	2,178	2,317	2,543

cm = centimeter; d = day; in = inch; lb = pound; kcal = kilocalorie; kg = kilogram; PAL = physical activity level; y = year.

[a] For U.S. population, based on NHANES 2015–2018, estimated for age group.

[b] Uses EER equations for adult men and women.

[c] Age used to predict EER is based on specific age: 51–70 y: 60 y; >70 y: 80 y; 19 y or older: 50 y.

[d] Inactive: 1.0 ≤ PAL < 1.53; low active: 1.53 ≤ PAL < 1.69; active: 1.69 ≤ PAL < 1.85; very active: 1.85 ≤ PAL < 2.5.

Source: National Academies of Sciences, Engineering, and Medicine. 2023.

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Table 18.10 Daily usual mean nutrient intake from food and beverages of adults aged >70 years compared to recommendation, NHANES 2015–2018

Nutrient	Usual Intake[a, b]		Recommended Intake[c]
	Males	Females	Males/Females
Protein, g/kg	1.10	1.03	0.66 grams/kg/day (EAR)
Mean	82	63	
Percent of energy	15.3	15.4	10–35% of calories (AMDR)
Carbohydrate, g	255	202	45–65% of calories (AMDR)
Total sugars, g	114	93	Limit to < 10% of calories from added sugar (Dietary Recommendations for Americans)
Dietary fiber, g	18.5	15.4	30/21 g/day (AI) 14 gm fiber/1,000 calories
Total fat, g	92	69	20–35% of calories (AMDR)
Saturated fat, g	32	23	< 10% of calories
Monounsaturated fat, g	32	24	Up to 20% calories
Polyunsaturated fat, g	21	16	Up to 10% calories
Cholesterol, mg	331	250	Keep as low as possible without compromising nutrient adequacy of diet.
Alcohol, g (12−15 g = 1 drink)	14	7	2 drinks/D for men and 1 drink/D for women

[a] Usual intakes from *What We Eat in America*, NHANES, 2015–2018, Tables A2–A10, individuals aged > 70. Available at https://www.ars.usda.gov/ARSUserFiles/80400530/pdf/usual/Usual_Intake_gender_WWEIA_2015_2018.pdf, accessed March 15, 2022.[65]

[b] *What We Eat in America*, NHANES 2017–2018, individuals 2 years and over (excluding breast-fed children), day 1. Available at www.ars.usda.gov/nea/bhnrc/fsrg, accessed March 15, 2022.

[c] Recommended intake data are based on Dietary Reference Intake (DRI), Institute of Medicine of the National Academies. *Dietary Reference Intakes: Energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids*. Washington, DC: National Academies Press, 2002. Acceptable Macronutrient Distribution Range (AMDR), Institute of Medicine.

Protein On average, older adults in North America meet or exceed the Recommended Dietary Allowance (RDA) for protein.[65] Older adults who are living alone, living in poverty, who are obese, or who have functional limitations are vulnerable to inadequate protein intake; this contributes to muscle wasting (sarcopenia), weak bones, a weakened immune status, and delayed wound healing. Evidence about the beneficial role of protein and alkaline diets on muscle mass[70] suggests that vulnerable seniors can benefit from individualized dietary advice.

It is not clear what constitutes an optimal amount of protein for individual older adults, although current protein guidelines are consistent for adults across all age groups. Results of studies are conflicting. A meta-analysis of nitrogen balance studies and a more recent study[71,72] showed that age alone does not alter protein requirements. However, other studies indicated that protein intake between 1.0 and 1.5 g per kg body weight per day might provide health benefits to older adults beyond the 0.8 g protein per kg current RDA.[73]

Nitrogen-balance studies used to determine current recommendations of 0.8 gram per kilogram (or 0.36 gram per pound) were done primarily with young adults, who have proportionately more muscle mass than older adults, man or woman, and are more efficient at maintaining nitrogen balance. Nitrogen balance is also easier to achieve when an individual is doing resistance training, when protein is ingested with adequate calories, and when the protein eaten is of high quality (such as meat, milk, and eggs; Table 18.14). However, for older adults who are following modified diets, who are cutting back on meat because they can't afford it or lack energy to prepare it, or who may eat too few calories, protein quality can make the difference between a good and a poor diet.

Despite adequate protein-intake levels of older adults on average, individual elders may be at risk for protein malnutrition. The following questions help to determine protein adequacy for older individuals:

- Based on total energy requirements, how much protein will meet the individual need?
- Are enough calories eaten so that protein does not have to be used for energy?
- If marginal amounts of protein are eaten, is the protein of high quality?
- Are there additional needs—wound healing, tissue repair, surgery, fracture, infection?
- Is the individual exercising? It is harder to achieve nitrogen balance while sedentary.

Consuming a low-calorie diet, as many older adults do, leads to a proportionately greater need for protein. Instead of consuming 10 percent of total calories in protein, needs might be better met near the 35 percent end of the AMDR as set by the Institute of Medicine. Furthermore, the protein is more effective when distributed evenly throughout the day, which can be difficult for someone who has gotten used to a cup of tea and a piece of toast in the morning.

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Table 18.11 Daily usual mean intake of selected micronutrients from food and beverages of adults aged >70 years compared to recommendation, NHANES 2015–2018

Nutrient, Unit of Measure	Usual Intake		Dietary Reference Intakes
	Males	Females	Males/Females
Vitamin A, mcg	805	703	625/500 = EAR
Vitamin D, mcg	6.0	4.3	15 (51–70y) 20 (>70y) = AI
Vitamin E, mg alpha-tocopherol	8.7	8.0	12 = EAR
Vitamin K, mcg	122	123	120/90 = AI
Thiamin, mg	1.77	1.30	1.0/0.9 = EAR
Riboflavin, mg	2.36	1.75	1.1/0.9 = EAR
Niacin, mg	25.8	19.1	12/11 = EAR
Vitamin B_6, mg	2.25	1.64	1.4/1.3 = EAR
Folate, mcg DFE	554	418	320 mcg = EAR
Choline, mg	368	274	550/425 = AI
Vitamin B_{12}, mcg	5.45	3.95	2.0 = EAR
Added Vitamin B_{12}, mcg	0.79	0.68	
Vitamin C, mg	91	80	75/60 = EAR
Sodium, mg	3,561	2,702	1500 = AI
Potassium, mg	2,930	2,280	3,400/2,600 = AI
Calcium, mg	969	779	1200 = AI
Phosphorus, mg	1,435	1,104	580 = EAR
Magnesium, mg	318	250	350/265 = EAR
Iron, mg	16.1	11.8	6/5 = EAR
Zinc, mg	11.90	8.60	9.4/6.8 = EAR
Copper, mcg	1.30	1.10	700 = EAR
Selenium, mcg	118	89.0	45 = EAR

Recommended intake data are Dietary Reference Intake (DRI) Institute of Medicine of the National Academies, Otten, J. J., Hellwig, J. P., & Meyers, L. D. (eds.), Institute of Medicine of the National Academies. *DRI Dietary Reference Intakes: The Essential Guide to Nutrient Requirements*. Washington, DC: The National Academies Press, 2006[63] and IOM.edu, for 2010 updates on calcium and Vitamin D and dietary reference intakes for sodium and potassium 2019 (https://www.ncbi.nlm.nih.gov/books/NBK538102/).

Sources: Usual intakes from *What We Eat in America*, NHANES, 2015–2018, Tables A2–A10, individuals aged > 70. Available at https://www.ars.usda.gov/ARSUserFiles/80400530/pdf/usual/Usual_Intake_gender_WWEIA_2015_2018.pdf, accessed March 15, 2022.

Decreasing muscle mass does not lead to lower protein requirements. In fact, someone who is losing muscle due to inactivity requires higher protein intake. Knowledge of the protein needs of older adults continues to evolve. The current approach, although still untested, is to optimize protein intake at specific meals and eating opportunities by consuming protein at intake levels slightly above the RDA (or at the higher end of the AMDR), and distributed evenly throughout the day. This may stimulate muscle synthesis and minimize the risk of sarcopenia in aging adults.[74,75]

Fats and Cholesterol The role of dietary fat does not seem to change with age; high saturated fat and *trans* fatty acid intake continue to be a risk factor for chronic disease. Keeping total fat between 20 and 35 percent of calories, replacing saturated fat with monounsaturated and polyunsaturated fat and minimizing dietary cholesterol intake are reasonable goals for older adults and discussed in the 2019 ACC/AHA Guideline on the Primary Prevention of Cardiovascular Disease.[76] Cholesterol intake for older adults is within current recommended levels (Table 18.10) in the

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Table 18.12 Using the MyPlate groups to estimate adequate carbohydrate (46 percent of kcal) and fiber portions (14 gm/1,000 kcal) for a 2,000-calorie diet

Basic Food Groups		
Number of Servings/ Grams of Carbohydrate Per Serving	**Carbohydrate, Grams**	**Approximate Total Fiber Content, Grams**
6 ounces of grain at 15 g each	90	12
2 cups of fruit at 20 g each	40	6
3 cups of dairy at 12 g each	36	0
2.5 cups vegetable at 8 g each	20	10
Total grams from basic groups	186	28
Other Carbohydrate-Containing Foods		
1 Tbsp sugar for coffee or tea	12	0
3 Fig Newton cookies	33	1
Total grams, including "other" group	231	29

Note: Mixed dishes such as soups, sandwiches, and salads count as partial servings from their contributing food groups.

Table 18.13 An example of fiber-containing foods that might comprise one day's intake

Food Item	Grams of Fiber
Oatmeal (½ cup) with wheat germ (¼ cup)	8
Banana	2
Peanut butter (2 Tbsp)/whole-wheat bread (2 slices)	6
Orange	3
Baked potato with skin	4
Green beans (½ cup)	3
Bran muffin (1 med)	2
Pear	4
Total dietary fiber	32

Note: Meat, poultry, fish, eggs, milk, sugar, and oils do not contain dietary fiber.

Table 18.14 Protein sources and protein quality measures: examples of protein scores used by the Institute of Nutrition of Central America and Panama (INCAP)

Protein Source	Chemical Quality Score*	True Digestibility in Humans
Meat, eggs, milk	100	95
Beans	80	78
Soy protein isolate	97	94
Rice	73	88
Oats, oatmeal	63	86
Lentils	60	Not available
Corn	50	85
Wheat	44	Refined, 96; whole wheat, 86

*Amino acid score relative to amino acid score of egg, the reference protein.

Sources: Data from Torun, B., Menchu, M. T., & Elias, L. G. *Recomendaciones dieteticas diarias del INCAP.* (Guatemala: INCAP, 1994); and Shils, M. E., Olson, J. A., M. Shike, M., et al. *Modern Nutrition in Health and Disease.* Philadelphia, PA: Lippincott, Williams & Wilkin, 1999.

2020–2025 Dietary Guidelines for Americans.[62] The Dietary Recommendations for Americans also suggests limiting *trans* fat and dietary cholesterol to be as low as possible without compromising the nutritional adequacy of the diet. The USDA Dietary Patterns are limited in *trans* fats and low in dietary cholesterol.

Recommendations for Fluid The water portion of total body weight decreases with age, indicating a shrinking water reservoir and resulting in a smaller safety margin for hydration maintenance. The DRIs for water are constant after age 19 and consist of 3.7 liters/D for males and 2.7 liters/D for females. Drinking six or more glasses of fluid per day prevents dehydration (and subsequent confusion, weakness, and altered drug metabolism) in individuals whose thirst mechanism has grown less sensitive. Dehydration is discussed further in Chapter 19.

To individualize fluid recommendations, provide 1 milliliter (mL) of fluid per calorie eaten, with a minimum of 1,500 mL. For a 2,000-calorie diet, that would be 2,000 mL or 2 liters of fluid, roughly 8 cups. Foods such as stews, puddings, fruits, and vegetables contribute significant amounts of fluid to the diet. Individuals who need additional calories can use milk, juice, shakes, and low-salt soups as nutrient-dense fluids.

Age-Associated Changes: Nutrients of Concern

The nutritional health of older adults depends on dietary habits that accommodate age-associated absorption and metabolism changes. The nutrients discussed in the following sections are of special concern for older adults because of age-associated metabolic changes or low dietary intake.

Vitamin A Diet surveys before the year 2000 reported that older adults were more likely to overdose on vitamin A than to be deficient in the nutrient, but the latest NHANES survey[65] showed dietary intake below the RDAs of 900 mcg and 700 mcg REA (retinol activity equivalents) for men and women, respectively (Table 18.11). Plasma levels and liver stores of vitamin A increase with age. This may be due to increased absorption but is more likely due to decreased clearance of vitamin A metabolites (retinyl esters) from the blood. Kidney disease further elevates serum vitamin A levels because retinol-binding protein, another vitamin A metabolite, can no longer be cleared

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from blood. This makes older adults more vulnerable to vitamin A toxicity and possible liver damage. The UL for vitamin A is 3,000 mcg (3 mg) for adults aged 19 and older, which could be reached if fish liver oils are taken in addition to daily vitamin supplements.

Vitamin A's plant precursor, beta-carotene, will not damage the liver, although supplements used as antioxidants to prevent cardiovascular disease have been linked to higher all-cause mortality.[77] Excess dietary beta-carotene, because it is water-soluble, may give old skin a yellow-orange tint, but it will not lead to hair loss, dry skin, nausea, irritability, blurred vision, or weakness as excess vitamin A would.

Vitamin D, Calciferol Age-associated metabolic changes affect vitamin D status, independent of dietary intake, primarily due to a fourfold decrease in the ability of aged skin to synthesize vitamin D.[78,79] In addition, older adults use more medications. Some of them, such as barbiturates, cholestyramine (bile acid sequestrant), phenytoin (Dilantin), and laxatives, interfere with vitamin D metabolism. Declining photochemical production ability may also be compounded by limited sunlight exposure due to wearing more clothes to stay comfortable, institutionalization or being homebound, and sunscreen use. Furthermore, in northern regions (above 42° north, the latitude of Boston and Chicago) between November and February, ultraviolet (UV) light is not powerful enough to synthesize vitamin D in exposed skin.[80] The sun's rays are even weaker in Edmonton, Canada (at 52° N latitude), so that previtamin D_3 is not synthesized between mid-October and mid-April. Dietary recommendations for vitamin D are higher for older adults than for any other population group (refer to last pages of this text), so individuals who live in these northern latitudes are at especially high risk for vitamin D deficiency. How far south does one have to go for the winter sun to convert vitamin D precursors? Tests in Los Angeles, at 34°N, showed vitamin D production in skin even in January. The sun's rays in Puerto Rico (latitude of 18°N) were even more effective.[80] Although humans store vitamin D, reaching and maintaining adequate serum 25 hydroxy vitamin D levels of 30 ng/mL (Chapter 1) is likely to require supplements for people living at northern latitudes. Holick and Chen's review found that 800–1,000 IU of vitamin D are needed to maintain adequate vitamin D serum levels, and this was especially so for nursing home residents.[79]

NHANES surveys of vitamin D intake[65] report significant dietary shortfalls (Table 18.11), which are reflected in lower serum vitamin D levels of older adults, especially older women. Levels of 30 ng/mL (75 nmol/L) or higher are needed for improving muscle strength, for dental health (including reduced periodontal disease), and to reduce risk of colorectal cancer.[81] A vitamin D level of 80 nmol/L optimizes intestinal calcium absorption.[79] Vitamin D's main role is in the maintenance of blood calcium levels and in keeping bones strong and healthy. This is addressed in the section on osteoporosis in Chapter 19.

The UL for vitamin D was increased from 50 mcg to 100 mcg (4,000 IU) in 2010. Symptoms of toxicity are hypercalcemia (high blood calcium levels), anorexia, nausea, vomiting, general disorientation, muscular weakness, joint pains, bone demineralization, and calcification (calcium deposits) of soft tissues. Toxicity is rare from food sources. Cod liver contains medicinal levels of vitamin D (about 21 mcg, or 840 IU, per teaspoon; check the label for amount) and may also contain vitamin A.

Vitamin E Also known as tocopherol, vitamin E is a potent antioxidant. Dietary intake is usually well below the DRI of recommended 12 mg alpha-tocopherol (Table 18.11) in the general population. Vitamin E plays a special role in the health of older adults due to its interaction with vitamin K and its antioxidant functions in maintaining cell membranes. Vitamin E is associated with enhanced immune function and cognitive status, although not with reduced cardiovascular disease risk.[77,82,83] The UL is 1,000 mg of alpha-tocopherol equivalent, which is obtained from supplements, fortified foods, or a combination of the two. Some research indicates that doses below the 1,000 IU (mg) level are safe; a meta-analysis reported safe levels at up to 400 IU.[84] At higher doses, vitamin E may increase all-cause mortality and is linked to longer blood-clotting times and tendency to hemorrhage. Aspirin, anti-coagulants, and fish-oil supplements also increase blood-clotting times and are incompatible with high vitamin E intake.

Vitamin K Interest in vitamin K is increasing because, in addition to its blood coagulation role, vitamin K–dependent proteins have been found in bone, vascular, and central nervous system tissues.[85] A systematic review and meta-analysis of supplemental intake of vitamin K on bone fractures in postmenopausal or osteoporotic patients showed reduced clinical bone fractures. These results, however, were inconclusive due to the small number of studies.[86] Bacteria in the large intestine synthesize vitamin K and, therefore, blood tests are needed to diagnose deficiency. For older populations, the concern is to maintain consistent dietary intake levels that do not interfere with warfarin (a vitamin K antagonist used as a blood thinner) therapy.[87] Additional vitamin K information is provided in Chapter 19, including a table showing vitamin K content of foods.

Vitamin B_{12} Vitamin B_{12} blood levels decrease with age, even in healthy adults. Population intakes of total vitamin B_{12} are higher than the DRI (Table 18.11), although intake of the synthetic form is below it. Why does this matter? Many older adults are unable to use B_{12} efficiently. Up to 30 percent of older adults suffer from atrophic gastritis and decreased absorption of B_{12}. In atrophic gastritis, a bacterial overgrowth of the stomach leads to inflammation

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and decreased secretion of hydrochloric acid and pepsin and subsequent inability to split vitamin B_{12} from its food protein carrier (Chapter 19). It takes years to develop a B_{12} deficiency, but once developed, the neurological symptoms are irreversible. Symptoms include deterioration of mental function, change in personality, and loss of physical coordination.

"Food first" is usually sound advice regarding nutritional needs, but B_{12} is one of the two vitamins better absorbed in synthetic or purified form. Folic acid is the other one. Synthetic, not protein-bound, vitamin B_{12} is found in fortified foods such as cereals and soy products. NHANES now tracks "added vitamin B_{12}" (Table 18.11). Protein-bound B_{12} is found in all animal products, although poultry is a surprisingly poor source (0.25 mcg of B_{12} in 3 ounces of chicken compared to 2.0 mcg in 3 ounces of ground beef).

Folate, Folic Acid Fortification of grain products with folic acid has led to intakes well above the EAR (and the RDA of 400 mcg DFE) (Table 18.11). Absorption of folate, like vitamin B_{12}, may be impaired by atrophic gastritis. Moreover, alcoholism is associated with folate deficiency and subsequent pernicious anemia. Medications commonly used by older adults—such as antacids, diuretics, phenytoin (Dilantin), sulfonamides, and anti-inflammatory drugs—affect folate metabolism. For persons with low serum folate levels, dietary increases of folic acid can lower risk of heart disease.[88] However, in the presence of vitamin B_{12} deficiency, high folic acid intake may mask the blood symptoms of vitamin B_{12} deficiency, which is more common in older adults than folic-acid deficiency, and can lead to neurological damage.

Iron Women's iron needs decrease after menopause, and on average, older men and women eat more iron than the DRI (Table 18.11). Like vitamin A, iron is stored more readily in the old than in the young. Excess iron contributes to oxidative stress, increasing the need for antioxidants to deal with oxidant overload. Fortunately, vitamin C intake, which increases iron absorption, also serves as an antioxidant.

Not every older person has adequate iron stores. Reasons for inadequate iron status include blood loss from disease or medication (e.g., aspirin), poor absorption due to antacid interference or decreased stomach acid secretion, and low caloric intake.

Calcium Research on calcium has led to several changes in recommendations over a relatively short time. A 1994 consensus conference sponsored by the National Institutes of Health recommended calcium intake for women depending on estrogen status; namely, 1,500 mg for women aged 50–64 not taking supplementary estrogen and 1,000 mg calcium per day for postmenopausal women taking estrogen. It was recommended that all men and women consume 1,500 mg calcium per day after age 65. This recommendation was lowered in 1997 and remained so in 2011, when the Institute of Medicine released the report that set the calcium RDA for men aged 51–70 and 71 years and older at 1,000 and 1,200 mg, respectively, and for women ages 51 and over at 1,200 mg.[89] Recommended levels are met by a small portion of the population; on average, calcium intake of older men and women ranges from 800 to 900 mg per day.

Most of calcium's role includes bone and tooth building and maintenance, but a fraction of the remaining calcium plays a role in nerve transmission, transport across cell membranes, and regulating heart and skeletal muscle. Absorption declines with age. Low calcium levels have been linked to risk of colon cancer, overweight, and hypertension. An example of the protective effects of calcium intake in the development of hypertension comes from work by Appel.[90] For example, Appel and the DASH Collaborative Research Group found that the subgroup of hypertensive individuals with higher calcium intake also had the greatest decrease in blood pressure. On average, participants who adhered to the Dietary Approaches to Stop Hypertension (DASH) diet reduced their blood pressure. The diet includes two or more servings of low-fat dairy products (1,265 mg calcium from food in the experimental group); 10 servings of fruits and vegetables; and limited fat, saturated fat, and cholesterol.

When it changed the RDAs for calcium in older adults, the National Academy of Sciences reduced the UL for calcium to 2,000 mg per day, which is less than twice the RDA. Excess calcium has a much lower bar for safety. A large selection of calcium-fortified foods and supplements presents the possibility of adverse effects of excess calcium. These adverse effects include kidney damage and calcium deposits in soft tissues and outside the bone matrix, such as bone spurs on the spine. High calcium intake may interfere with zinc, iron, and magnesium absorption, and it may result in elevated urinary excretion of calcium, leading to new kidney stones in individuals with a history of kidney stones. Low blood calcium levels lead to muscle cramps and twitches (tetany).

Magnesium Adequate magnesium intake) is needed for bone and tooth formation, nerve activity, glucose utilization, and synthesis of fat and proteins. An indication of the wide-ranging functions of magnesium is that it plays a part in over 300 enzyme systems. Age does not seem to affect magnesium metabolism, and the RDA is constant at 420 mg for men and 320 mg for women after age 31. The UL is 350 mg from nonfood (supplementary) sources. Older adult average intake is below the EAR (Table 18.11). Magnesium deficiency can result not only from low intake but also from malabsorption due to gastrointestinal disorders, chronic alcoholism, and diabetes. Signs of deficiency include personality changes (irritability, aggressiveness), vertigo, muscle spasms, weakness, and seizures.

Drugs used by older adults, such as magnesium hydroxide or citrate laxatives, may lead to magnesium overdose.

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Signs of magnesium toxicity are diarrhea, dehydration, and impaired nerve activity. Food sources including milk, yeast breads, coffee, ready-to-eat cereals, beef, and potatoes do not result in toxicity.

Sodium and Potassium Meeting the ambitious sodium guidelines will be especially difficult for older adults. At the 1,200 mg sodium level, foods need be prepared without added salt or sodium compounds. Even foods that do not taste salty can be too high in sodium. For example, a bowl of regular cornflakes, 2 slices of whole-wheat bread, 2 ounces of deli roast beef, and 3 cups of milk add up to 1,500 mg sodium, but only 665 calories. One thing that would help to balance extra sodium intake is an adequate potassium intake (RDA = 4,700 mg/day). However potassium intakes are below the AI (Table 18.11). Beverages alone could contribute nearly half of the day's potassium. The following frequently consumed beverages and their potassium content per 8 fluid ounces shows that fluids can contribute nearly half of the day's potassium: coffee (115 mg), tea (90 mg), milk (365 mg), orange juice (445 mg), grape juice (200 mg), and lemonade (63 mg). Fruits and vegetables are excellent sources, especially potatoes, sweet potatoes, greens, beans, bananas, and tomatoes. Potassium and sodium are the two electrolytes responsible for water balance in humans. The DASH diet, with its abundant fruits and vegetables, helped to reduce blood pressure even when sodium intake was above 1,500 mg.

Nutrient Supplements: When, Why, Who, What, and How Much?

Most people don't tell their health-care provider about the supplements they take, unless asked. Despite inconsistent evidence of benefit combined with growing evidence of risk,[91,92] the dietary supplement industry is booming with sales that reached an estimated $55.7 billion in 2020, including $21.2 billion for all supplements containing vitamins, minerals, or both.[93]

When to Consider Supplements When do older adults benefit from taking nutrient supplements? It depends on the circumstances and on the nutrient. Recovery from illness and trauma is definitely aided by supplemental formulas, including vitamins, minerals, and energy nutrients such as protein and fatty acids. This section deals with multivitamin and mineral supplements. These can decrease infection,[94,95] but the evidence is weak and conflicting.[96] Supplements have not been shown to have a preventive benefit when taken by well-nourished aged populations. Here's what an NIH panel concluded after reviewing the role of vitamins and minerals in the prevention of chronic disease in 2006, long before the market spiked.[97]

Multivitamin/mineral supplement use may prevent cancer in individuals with poor or suboptimal nutritional status. The heterogeneity in the study populations limits generalization to the U.S. population. Multivitamin/mineral supplements conferred no benefit in preventing cardiovascular disease or cataract, and may prevent advanced age-related macular degeneration only in high-risk individuals. The overall quality and quantity of the literature on the safety of multivitamin/mineral supplements is limited.

This statement has not slowed growth of the multibillion-dollar supplement industry, even though this NIH panel conclusion still holds, and evidence about negative outcomes is accumulating. Health-conscious adults take supplements as insurance, even as the outdated consensus of "it can't hurt" is being replaced by knowledge of potential problems of excess. Nutrient research is complicated, as in the case of vitamins A, E, and beta-carotene, where the pill forms of a nutrient turned out to be harmful while food forms promoted health.[98] Nutrient contributions of enriched, fortified, and functional foods blur the lines of what counts as a supplement. How does one count the cereal that supplies 100 percent of the Daily Value of vitamins and minerals in one bowl? Is calcium-fortified orange juice a food or a dietary supplement? Calcium-enriched foods are good examples to use in calculating how close one's intake is to the UL of a nutrient. Calcium's UL of 2,000 mg is less than twice the RDA of 1,200 for adults over age 70, making the margin of error in reaching potentially toxic amounts very slim indeed. If supplements no longer serve as insurance for well-nourished older adults, when is it worth taking nutrient supplements?

Vitamin B_{12} and folic acid may be one instance. For a significant part of the population, these two vitamins are better absorbed in a synthetic form than in their protein-bound food form—but this becomes important only when normal metabolic processes fail.

It is possible for older adults to live well without dietary supplements. However, population surveys show that diets of many older persons fall short of meeting recommended nutrient levels (Table 18.11), and appropriately used supplements fill nutritional gaps.[99] Some age-associated circumstances make an individual vulnerable to malnutrition and more likely to benefit from dietary supplements. Such nutritional risk factors include the following:

- Lack of appetite resulting from illness, loss of taste or smell, or depression
- Diseases or bacterial overgrowths in the gastrointestinal tract that prevent absorption
- Poor diet due to loss of function, dieting, or disinterest in food
- Avoidance of specific food groups such as meats, milk, or vegetables
- Use of substances that affect diet, absorption, or metabolism: tobacco, alcohol, drugs

Who Takes Supplements and Why? About 40 percent of individuals aged 60 and older took multivitamin/mineral supplements in the past 30 days during the

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Table 18.15 Selected dietary supplements used by older adults for selected conditions

Condition or Health Status	Supplement
Poor appetite or dieting, leading to intake below 1,200–1,600 calories	Multivitamin/mineral
Weight loss, chronic underweight	Add high-calorie/protein foods/fats as oils
Vegetarian or vegan	Vitamins B_{12}, D, calcium, zinc, iron
Age-related macular degeneration	AREDS formulation (high levels of C, E, A, Zn, Cu) for high-risk and current AMD; no evidence for preventing AMD incidence
Constipation	Fiber (cellulose, bran, psyllium), together with fluid; strengthening of gut and core muscle
Diarrhea	Fluid, multivitamin/mineral
Energy boosters	Evaluate total nutrient intake, adequate calories, iron if blood levels are low; guard against excess stimulant (caffeine and guarana)
Osteoporosis	Vitamins D, calcium, fluoride, magnesium—follow doctor's recommendation
Sleep aids	Milk and carbohydrate at bedtime; possibly melatonin, secretion of this biorhythm regulator decreases with age Avoid guarana, caffeine, and alcohol near bedtime

NHANES 2017–2018.[100] Adults' usage increases with age. The individuals most likely to take supplements are White, women, with more education and with higher incomes. They eat fruits and vegetables and are less likely to be obese, to smoke, or to have preexisting illnesses. Older adults are motivated by wellness and want to take responsibility for their own health. They use vitamin and mineral supplements to make them feel better, to have more energy, to improve health, and to prevent or treat disease.

What to Take? The first consideration when asking, "What should I take?" is safety. Is there a chance that taking this supplement is harmful? Supplements are not tested and regulated like medicines, even if consumers use them to promote health and wellness or to ward off disease. The Food and Drug Administration requires label and package inserts be accurate. But press about a product is governed by the Federal Trade Commission (FTC) and is considered free speech. Articles or media messages about dietary supplements can make unsubstantiated claims (Lose pounds! Perform all night! Erase wrinkles!). Unlike drugs, a dietary supplement may promise medicinal effects, but it is up to the buyer to look into proof of safety and efficacy. A systematic review and meta-analysis of primary prevention trials showed insufficient evidence to support the use of dietary supplements in the primary prevention of cause-specific death, incidence of CVD, and incidence of cancer.[101]

USP (United States Pharmacopeia) A nongovernmental, nonprofit organization (since 1820); establishes and maintains standards of identity, strength, quality, purity, processing, and labeling for health-care products.

NSF International, a nongovernmental, nonprofit that also tests dietary supplements.

Considerations that guide supplement choices are especially important for older adults, who use more medications than younger adults, and these are addressed by the following four questions:

1. Does the supplement supply the missing nutrients?
2. Are there unwanted nutrients, and if so, can you live with them?
3. Is the dose safe when all supplements and fortified foods are combined?
4. Does the supplement carry a **USP** (U.S. Pharmacopeia, a mark that indicates that the manufacturer followed recognized standards when making the product) or **NSF** (NSF.org; NSF International tests consumer products, including dietary supplements) code to assure potency and purity?

How Much to Take? In general, multivitamin/mineral supplements are developed for use in physiologic rather than high-potency doses. Physiologic dose formulas unique to older adults are available without iron, with less vitamin A, and with additional vitamins B_{12} and D.

Generously fortified breakfast cereals, "power" bars, and fortified beverages count as vitamin or mineral supplements. On average, dietary intakes of older adults lack sufficient choline; calcium; magnesium; potassium; and vitamins A, D, E, and K, but are adequate in the rest. Additional vitamins and minerals are superfluous and possibly unsafe (e.g., beta-carotene supplements) (Table 18.15).

Dietary Supplements, Functional Foods, and Complementary Medicine

Complementary and alternative medicine (CAM) therapies often involve herbs, stimulants, functional foods, and

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nutraceuticals. Adults use hundreds of nonvitamin and nonmineral products (e.g., energy shots, glucosamine chondroitin, CoQ10, melatonin, plant stanols), including some that have toxic effects at normal doses (e.g., blue cohosh, chaparral). A commentary in the journal Evidence-Based Complementary and Alternative Medicine estimated that only 7 percent of complementary medicine is based on sound evidence.[102] Furthermore, this estimate may be optimistic. Considering the explosion of functional foods in the market place, and the desire for natural treatments and cures, older adults are especially vulnerable. They eat fewer calories, are less resilient physically, take more medicines that might interact with supplements, and they have a smaller tolerance for mistakes in supplement use.

In some cases, the growing availability of functional foods can benefit nutrient-deficient older adults. They may appreciate the convenience of nutrient-dense foods such as calcium-fortified breads and orange juice; fortified high-fiber cereals; prebiotics such as inulin in fiber bars; probiotics in yogurt with live cultures; soy milks; breakfast powders with whey protein; and various fortified chews, bars, and drinks. However, regular users of functional foods, no matter what age, need to track all sources of their dietary vitamin and mineral intake in order to avoid potentially toxic nutrient levels (Table 18.16). Advice that "you can't overdose on nutrients from food" does not apply to fortified foods.

Nutrient Recommendations: Using the Food Label

The Nutrition Facts panel on food packages is structured to provide nutrient content information relative to a 2,000-kcal diet and in relation to nutrient needs.

A few of the recommended nutrient levels for older adults (aged 70 years and older) differ from those used as reference values (DV) for the nutrition label (Table 18.16). The UL shows upper limits that are considered safe. ULs range from < 2 to > 60 times the RDA, making it impossible to generalize about the safety of excess nutrients. Older adults can use the DV percentages on food labels for dietary guidance if they adjust them to get more than 100 percent of calcium and vitamins D and C and less than 100 percent of vitamin A, iron, and zinc. For example, the calcium DV is 1,000 mg but the RDA for 71-year-olds is 1,200 mg, so a food serving containing 20 percent of the DV (200 mg) provides 16.6 percent of the day's RDA of 1,200 mg. Iron is important to track because it has a low UL compared to the DV (factor of 2.5). The DV is more than twice the RDA (18/8 mg) of an older adult. For a 51+ adult, the 8-mg RDA is only 44 percent of the DV, which might easily be consumed in a single serving of cereal. Using the DV for the needs of older adults can be cumbersome; it requires vision to read the label and dexterity and mental acuity to do the math and track it. It also requires motivation. On the other hand, older adults are motivated to guard their health.

Cross-Cultural Considerations in Making Dietary Recommendations

Food habits develop in cultural contexts, and we can learn about them in various ways. Travel through the United States would allow us to observe cultures that make up our society. Visiting ethnic restaurants, stores, and farmer's markets can be another way to get a glimpse of cultural food diversity. Cookbooks, films, talking with individuals about their food history, and participating in ethnic celebrations are other sources of insight into food patterns of various cultures. Each new immigrant wave adds unique food traditions to the country's mix. Older adults may be stronger advocates for upholding traditional food patterns than young people are. In working with them on food issues, it is useful (and interesting) to determine the cultural history of their food and lifestyle habits.

National food-monitoring programs survey the population with proportionately larger samples drawn from underrepresented groups in order to develop a balanced picture of the whole population. The United States is home to rapidly growing Hispanic, Asian, Russian, Middle-Eastern, and African immigrant groups. The U.S. Census tracks ethnic populations, but it is completed only once every 10 years. The local Area Agencies on Aging and Nutrition Programs also track population trends, and these are likely to yield greater insight about some of the smaller ethnic population groups in their unique communities and regions.

Cultural differences are reflected in approaches to dietary guidance. For example, Chile has separate guidelines for older and younger adults. In New Zealand, older adults are encouraged to socialize at mealtimes to improve appetite. In France, South Korea, and Japan, people of all ages are encouraged to enjoy mealtimes and take pleasure in eating. Other unique guidelines are those of China, which suggest people eat 20–25 grams (nearly an ounce) of fish daily. Guatemala uses a bean pot as a nutritional icon. India has developed one set of guidelines for the rich (i.e., overall energy intake should be restricted to levels commensurate with the sedentary occupations of the affluent, so that obesity is avoided; total fat intake is not to exceed 20 percent of total energy; and use of clarified butter, a prized Indian culinary ingredient that should be restricted to special occasions and one for the underprivileged (addressing the fact that at least one-third of the households in India are not able to afford even the minimum nutritional requirements, even though they are spending

nutraceutical Combination of words *nutrient* and *pharmaceutical* to indicate a food-derived compound that can act as a drug, such as red yeast rice, a statin-like compound.

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Table 18.16 Vitamin and mineral levels for nutrition labeling (Daily Reference Values or DV) compared with Dietary Reference Intakes (DRI) and Tolerable Upper Intake Levels (UL) for older adults

Vitamin and Mineral Components of the Nutrition Label				
		DRI for Adults Over 70		
Mandatory Nutrients	Daily Values (2020) All Adults	Males	Females	Upper Limit (UL)
Vitamin A, RAE	900	900 RE	700 RE	3,000 RE
Vitamin C, mg	90	90	75	2,000
Sodium, mg	2,300	1,200	1,200	2,300
Calcium, mg	1,300	1,200	1,200	2,000
Iron, mg	18	8	8	45
Voluntary Vitamin and Mineral Components of the Nutrition Label				
Vitamin D, mcg	20	15	15	50
Vitamin E, mg	15	15	15	1,000
Vitamin K, mcg	120	120	90	–
Thiamin, mg	1.2	1.2	1.1	–
Riboflavin, mg	1.3	1.3	1.1	–
Niacin, NE, mg	16	16	14	35
Vitamin B_6, mg	1.7	1.7	1.5	100
Folic acid, DFE mcg	400	400	400	1,000[a]
Vitamin B_{12}, mcg	2.4	2.4	2.4	–
Biotin, mcg	30	30	30	–
Pantothenic acid, mg	5	5.0	5.0	–
Phosphorus, mg	1,250	700	700	3,000
Iodine, mcg	150	150	150	1,100
Magnesium, mg	420	420	320	350[b]
Zinc, mg	11	11	8	40
Selenium, mg	55	55	55	400
Copper, mcg	900	900	900	10,000
Manganese, mg	2.3	2.3	1.8	11
Chromium, mcg	35	30	20	–
Molybdenum, mcg	45	45	45	2000
Chloride, mg	2,300	1,800	1,800	–
Potassium, mg	4,700	4,700	4,700	–
Choline, mg	550	550	425	3,500
Fluoride, mg	–	4.0	3.0	10

[a]Synthetic.

[b]Nonfood sources.

Source: https://www.fda.gov/food/new-nutrition-facts-label/daily-value-new-nutrition-and-supplement-facts-labels, accessed March 1, 2022.

80 percent of their income on food). These recommendations identify food combinations that are most likely to meet recommended dietary intakes.

Listening carefully, communicating effectively, and avoiding misinterpretation in intercultural settings is probably the most important thing a nutritionist can learn to do when working with older adults from various cultures. Cultural competence requires skill in transferring information, developing and maintaining relationships, and gaining compliance. Developing individual skills takes time, commitment, and practice. On the other hand, nutrition education and guidance tools have been developed in many languages and for diverse cultures, although not typically for older adults of ethnic groups. Culturally appropriate resources can be found through local extension services, cross-cultural education centers, diabetes education programs, public health agencies, and some commodity groups.

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18.7 Food-Safety Recommendations

Older adults with a compromised immune status are particularly vulnerable to foodborne illness. No one knows exactly how widespread this problem is because many foodborne illnesses are not reported when individuals think they have the flu.

Poor food-handling practices leading to microorganism growth are generally to blame for foodborne illnesses. Impaired functioning may result in impaired food handling practices. Signs and symptoms of foodborne illness include gastrointestinal distress, diarrhea, vomiting, and fever and may appear within half an hour of eating a contaminated food or may not develop for up to 3 weeks.

Leading practices that put an older person at risk are as follows:

- Improper holding temperatures of foods
- Poor personal hygiene
- Contaminated food-preparation equipment (cutting boards, knives)
- Inadequate cooking time

Limited vision, decreased sense of smell, or forgetfulness may get in the way of actions that keep food nourishing by keeping it safe. To combat this, the recommendations are to:

- Wash hands and surfaces often.
- Separate raw, cooked, and ready-to-eat foods while shopping, preparing, and storing.
- Cook foods—especially raw meat, poultry, fish, and eggs—to a safe temperature.
- Refrigerate or freeze perishable or prepared foods within 2 hours.
- Follow the label for food-safety preparation and storage instructions.
- Serve hot foods hot (140°F or above) and cold foods cold (40°F or below).
- When in doubt, throw it out!

18.8 Physical Activity Recommendations

Exercise is a true fountain of youth. Physical activity (PA) builds lean body mass, helps to maintain balance and flexibility, contributes to aerobic capacity and to overall fitness, improves cognitive performance in previously sedentary older adults, and is associated with overall psychological well-being.[7] Older people benefit from PA even more than younger people do because strength training is the only way to maintain and build muscle mass. In addition to strength gains, increased muscle mass increases caloric needs. Higher caloric intake increases the chances of optimal nutrient intake. Low activity levels as well as deteriorating strength, endurance, and sense of balance are associated with, but not caused by, increasing age.

Age does not hinder training effects. The American College of Sports Medicine position statement describes the effects of exercise and physical activity on older adults and includes recommended exercise prescriptions made collaboratively with the American Heart Association.[7]

Physical Activity Guidelines

How can one predict whether PA will exacerbate existing medical conditions? Physician screening or assessment by completing a questionnaire like the one in Table 18.17 can identify potential contraindications or problem areas. A more detailed assessment to evaluate cardiovascular fitness, strength, function, balance, flexibility, body composition, and bone density can be made by an interdisciplinary team. Individuals, including those with physical limitations such as heart disease or inability to stand, can be cleared for participation.

The 2018 Physical Activity Guidelines for Americans[103] complements the 2020 Dietary Guidelines[62] and include key recommendations for physical activity for various age groups. Adults aged 65 and older are encouraged to follow the adult guidelines as conditions allow, and to include exercises that includes balance training as well as muscle-strengthening and aerobic activities. Level of fitness and chronic conditions determine the frequency, intensity, and duration of exercise sessions for older adults:

- Muscle strengthening that involves all major muscle groups on 2 or more days per week
- At least 150 to 300 minutes per week of moderate intensity aerobic activity
- Drink water when exercising because thirst may be blunted
- Ensure adequate protein for muscle building throughout the day

Because bed rest and inactivity lead to bone and muscle wasting, everyone, including institutionalized individuals, can benefit from exercise. Refer to Case Study 18.1 for an instance where exercise can be an integral part of treatment.

18.9 Nutrition Policy and Intervention for Risk Reduction

Nutrition policy promotes health by including nutrition education for individuals and population in public health interventions. The ultimate goal of nutrition intervention is to improve health outcomes.

Nutrition Education

Contrary to some beliefs, older people do learn and change. Someone born in 1940 has seen the invention of

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Table 18.17 Keep moving: Fitness after 50 chart

A.	Do I get chest pains while at rest and/or during exercise?
B.	If the answer to question A is yes: Is it true that I have not had a physician diagnose these pains yet?
C.	Have I ever had a heart attack?
D.	If the answer to question C is yes: Was my heart attack within the last year?
E.	Do I have high blood pressure?
F.	If you do not know the answer to question E, answer this: Was my last blood pressure reading more than 150/100?
G.	Am I short of breath after extremely mild exertion, and sometimes even at rest or at night in bed?
H.	Do I have any ulcerated wounds or cuts on my feet that do not seem to heal?
I.	Have I lost 10 pounds or more in the past 6 months without trying and to my surprise?
J.	Do I get pain in my buttocks or the back of my legs—my thighs and calves—when I walk? (This question is an attempt to identify persons who suffer from intermittent claudication. Exercise training may be extremely painful; however, it may also provide relief from pain experienced when performing lower-intensity exercise.)
K.	When at rest, do I frequently experience fast, irregular heartbeats, or, at the other extreme, very slow beats? (Although a low heart rate can be a sign of an efficient and well-conditioned heart, a very low rate can also indicate a nearly complete heart block.)
L.	Am I currently being treated for any heart or circulatory condition, such as vascular disease, stroke, angina, hypertension, congestive heart failure, poor circulation to the legs, valvular heart disease, blood clots, or pulmonary disease?
M.	As an adult, have I ever had a fracture of the hip, spine, or wrist?
N.	Did I have a fall more than twice in the past year (no matter what the reason)? (Many older persons have balance problems, and at the initiation of a walking program will have a high chance of falling. These persons may benefit from balance training and resistance exercise before beginning a walking program.)
O.	Do I have diabetes?

Source: From Evans, W. J., & Cyr-Campbell, D. Nutrition, exercise, and healthy aging. *JADA*. 1997; 97:632–638.

microwaves, television and TV dinners, and a whole host of computer-controlled kitchen appliances, not to mention computers, smartphones, and online anything. To age is to adapt. Learning new nutrition habits is part of aging. Nutrition education is different from education in general because its goal is changed dietary behaviors. Nutrition education consists of a set of learning experiences to facilitate voluntary adoption of nutrition-related behaviors that are conducive to health and well-being. Several requirements must be met for nutrition education—that is, behavior change—to occur (Figure 18.4). Think of them as the 4 Cs of nutrition education.[104]

1. *Commitment*. Commitment means being motivated to adopt health-promoting behaviors and intending to adopt and maintain a new food behavior.
2. *Cognitive processing*. Understanding how a food behavior contributes to health and planning how it will fit into your life constitutes cognitive processing.
3. *Capability*. Acquiring the skills to practise new food behaviors is part of nutrition education. An example is learning to identify whole-grain breads or to prepare vegetables when intending to adopt a high-fiber diet.
4. *Confidence*. "Nothing breeds success like success!" The best predictor that someone will practice new dietary habits is their personal confidence in being able to do so.

Educational sessions for older learners are best designed around their potential limitations, such as declines in visual acuity and hearing loss.[104] Adaptation for written material includes:

- Larger type size
- Serif ("with feet") lettering (Arial is a typeface with no serifs; Times Roman has serifs)
- Bold type
- High contrast (black on white)
- Nonglossy paper to decrease glare
- Avoidance of blue, green, and violet (paper and print color) due to decreased ability to discriminate among these colors
- Reading level of fifth to eighth grade for general audiences

Educational strategies can result in better diets for individuals, but these alone are not sufficient to enhance the dietary patterns of populations. Nutrition policies reflect community environments. Cultural environments support, ignore, or punish desired behavior change. An example of a culturally supportive environment is a peer group that values health and fitness; group members will help each other to achieve and maintain health-promoting behaviors. For instance, members may belong to a biking group, share in farmers' market trips, and serve healthful foods when entertaining. The 80-year-long Terman study, reported

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Case Study 18.1 Richard—Spiraling Out of Control?

Richard, a retired computer company executive, eats out four times a week since his wife died last year. Meals at home consist of microwave dinners or supreme pizza. He belongs to a health club, which he visits three times a week, and where he has many friends. Occasionally, Richard and his friends go out for beers after their workout. Shortly after his 69th birthday (2 years ago), he was diagnosed with type 2 diabetes. Last week, he visited the clinic for his annual checkup. He was measured at 5 feet 9 inches (1.75 m) and weighed 235 pounds (106.8 kg). His doctor is worried about Richard's family history of heart disease.

Questions

1. What would you ask Richard about his food and fitness routine?
2. Calculate Richard's BMI. How does it compare to guidelines? He wants to know whether BMI is an accurate measure of his body fat. How might you answer?
3. As his nutritionist, what nutrition remedies would you explore to help Richard?
4. What fluid recommendation would you make?
5. What sort of monitoring and evaluation plan could you and Richard devise to track his weight management?



Daniel Grill/Tetra images/Getty Images

in The Longevity Project,[105] describes many examples of structuring one's environment to support longevity.

Food and nutrition policies arise from public values, beliefs, and opinions that define the cultural context in which dietary behaviors exist. Policies can be overt or unspoken. Public policies supporting the health of older adults in the United States are evident in the Social Security program, which provides financial support for post-retirement living, including health-care and nutrition counseling.

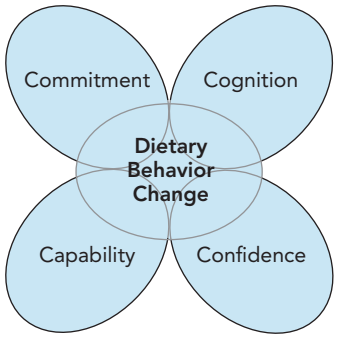


Figure 18.4 Four essential elements to achieve and maintain individual dietary behavior change.

Source: Based on Krinke, U. B. Effective nutrition education strategies to reach older adults. In R. R. Watson (Ed.), *Handbook of Nutrition in the Aged.* Boca Raton, FL: CRC Press, 2001.

18.10 Community Food and Nutrition Programs

The U.S. Department of Health and Human Services (HHS) administers the Older Americans Act Nutrition Programs (OAANP), which includes a whole array of nutrition and community services. Home-delivered and congregate meal programs, with nutrition screening and counselling, are provided to older adults nationally through an aging network of state units on aging, area agencies on aging, and tribal and Native American organizations. HHS also administers Social Security programs that provide basic living expenses for older adults and health-care coverage through Medicare. Other programs administered by the U.S. Department of Agriculture that target older adults include: the Commodity Supplemental Food Program, which distributes to low-income adults

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aged 60 and older food items with nutrients typically lacking in this population; Senior Farmer's Market which provides vouchers for fresh produce; and the Child and Adult Care Food Program (CACFP), which provides nutritious meals to older adults in care centers.[106]

These programs, in addition to the USDA Supplemental Nutrition Assistance Program (SNAP) and a myriad of home and community-based services offered as part of the OAA, help older adults remain in their homes indefinitely, sometimes referred to as "aging in place." Aging in place does not necessarily mean living in one home for a lifetime. Ideally, it means having the choice to grow old in one's preferred community. Liveable communities offer a spectrum of options for residents of all ages. Supportive services are customized to accommodate those who are fully active and have no impairments, those who require limited assistance, and those with more severe impairments who require care in long-term care facilities are basic to creating liveable communities.

Other nongovernmental food and nutrition programs that contribute to the continuum of nutrition services include food pantries, soup kitchens, and screening and referral services.

OAANP: Promoting Socialization and Improved Nutrition

Congress first appropriated funds under the Older Americans Act of 1965 to begin the OAANP (previously called the Elderly Nutrition Program). The OAANP was created to alleviate poor nutritional intake and reduce social isolation among older adults. It was based on evidence that older adults do not eat adequately because of the following:

1. Lack of income limits ability to purchase food.
2. Lack of skills limits ability to select and prepare nourishing meals.
3. Limited mobility affects shopping and meal preparation.
4. Feelings of isolation and loneliness decrease the incentive to eat well.

Title IIIC of the Older Americans Act, is a community-based nutrition program that provides meals (congregate and home-delivered), increased social contact, nutrition screening and education, and information and linkages to other support programs and services, as well as volunteer opportunities. Anyone who is 60 or more years of age (and in some cases, their spouses or caregivers regardless of age) is eligible to participate in the congregate dining program; home-delivered meal clients must be unable to leave home without assistance and unable to prepare their own meals. Although the OAANP is not means tested and individuals do not need to be of low-socioeconomic status to participate, congregate meal sites are targeted to neighborhoods where older, frail, impoverished seniors live. Meal sites are located in community centers, senior centers, civic buildings, subsidized housing units, schools, and other accessible locations. Home-delivered meals are especially targeted to low-income minorities, rural older adults, and those with limited English proficiency or those at risk of institutional care. Individuals contribute toward the cost of the meal, according to their means and based on a suggested donation. The last major national evaluation of the OAANP, completed in 1996, showed that for every $1.00 of Title III funds spent on congregate services, it is supplemented by an additional $1.70 from other sources; the average cost of a congregate meal was $10.69, and a home-delivered one was $11.06.[107] Title VI grant programs are similar to Title III programs and were established to help deliver social and nutrition services to older Native Americans, Alaskan Natives, and Native Hawai'ians. Other service variations to meet the needs of frail older seniors include multiple meals, weekend meals, take-home snacks, liquid supplements, nutrition screening and education, and one-to-one nutrition counseling. Also available are diets adapted for medical, religious, and cultural reasons.

Nutrition programs for older adults have successfully brought together millions of people to socialize and enjoy nutritious meals. In FY 2009, about 240 million congregate and home-delivered meals were served to approximately 2.6 million older adults.[108] The Older Americans Act 2000 Amendment, Section 339 (Nutrition) (H.R. 782), states that nutrition projects shall use a dietitian (or person with compatible expertise), provide a minimum of one-third of the daily RDAs, and comply with the Dietary Guidelines for Americans. A review of the literature showed that the HDM program is well targeted, efficient, and well liked; it provides quality food to needy individuals; and helps individuals remain living independently. HDMs was also shown to decrease institutionalization of older adults and resulting health-care expenditures.[109] Results from a national study also showed that participants in the HDM may be at greater risk of malnutrition without the meal program.[110] Increasing socialization was one of the original program goals and continues to be one of the outcomes. Relative to the general older population, participants are older and more likely to be women, to belong to an ethnic minority, to live alone, and to have incomes well below poverty level.

The Promise of Prevention: Health Promotion

Aging Boomers who expect to enjoy an active adulthood are driving longevity and aging research. Lifelong caloric restriction may not find many converts, but emulating the habits of long-lived populations is gaining interest. Dan Buettner has been studying regions of the world inhabited by disproportionately high numbers

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of centenarians. In describing the lives of these healthy older residents of Okinawa, Sardinia, Costa Rica, and North America in a book called *The Blue Zones,*[111] Buettner compiled a list of nine habits and traits among these population groups:

1. Being active as a regular part of daily life
2. *Hara hachi bu,* which means to stop eating when one is 80 percent full
3. Eating more beans, whole grains, vegetables, nuts, and fruits while limiting meats and processed foods
4. Drinking red wine, in moderation
5. Having a reason to get up in the morning, a *plan de vida* or *ikigai*
6. Making time to relieve stress
7. Belonging to, and participating in, a spiritual community
8. Making family a priority and upholding rituals and traditions
9. Picking the right tribe, that is, surrounding yourself with people who share long-life values

Residents of places like Okinawa, Sardinia, and Loma Linda are supported by their culture throughout life. Although good nutritional habits make a greater impact when started early in life, sometimes individuals are not motivated to pursue these risk-reduction strategies until they retire or experience a health problem. Successful strategies to reach an older audience address specific population needs and interests. The wave of aging baby boomers is less accepting of the status quo. Should the myth that a 70-year-old is too old to learn and practice health-promotion strategies still exist when they themselves turn 70, they will certainly disprove it! Boomers believe the words of the poet Robert Browning: "Grow old along with me, the best is yet to be!"

Key Points

1. Functional ability (the demonstrated ability to carry out activities of daily living) is more important than chronological age in assessing the health status of older adults.
2. Good nutrition, good health habits, environment, access to health care, and genetics contribute to human life expectancy, which is still significantly shorter than the potential human life span. Theories of aging, such as wear-and-tear theories, help to explore which factors contribute most to a longer, disease-free life.
3. Of all the physiological changes associated with aging, loss of lean body mass and the concomitant gains of body fat may well be the most important in determining functional age.
4. "Use it or lose it" applies to both the body and the mind: keep learning to maintain acute brain function, stay active to build muscle and bone, eat well to maintain and repair tissue, and cultivate a positive approach to life to improve longevity.
5. The DETERMINE acronym is a reasonable summary of warning signs associated with poor nutritional health.
6. While adults in general consume more than enough calories and protein, clusters of older adults may be lacking in adequate dietary protein and energy.
7. The thirst mechanism of older adults is not as sensitive as that of younger adults, placing them at higher risk of dehydration.
8. Physiological changes that lead to malnutrition in older adults are decreased absorption of vitamins D and B_{12} and increased storage of vitamin A and iron.
9. In general, older adults eat better than do younger adults, but they do not consume enough vitamin A, D, E, K (men), choline, calcium, magnesium, or potassium to meet recommended intake levels.
10. Vitamin and mineral supplements can be helpful for older adults who have lost their appetite; avoid certain food groups; have poor diets due to loss of function, dieting, or depression; or who have gastrointestinal bacterial overgrowth that prevents nutrient absorption.
11. Excellent food safety practices are especially important for older adults, who may be more vulnerable to infection for many reasons, such as a higher prevalence of chronic diseases, sensory and functional losses, lower immune system, and decreased resilience in healing and recovery from illness.
12. Older adults are often more interested in nutrition education and health promotion than are younger adults. The stereotype that older adults will not change is just that: an old stereotype.

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Review Questions

1. Older adults have proportionately more illness than younger adults, and the two leading causes of death are heart disease and cancer.

   _____ True _____ False

2. The CDC suggests that longevity depends more on lifestyle factors than on genetics.

   _____ True _____ False

3. U.S. life expectancy at birth is the highest in the world.

   _____ True _____ False

4. Fat-free mass or lean body mass tends to shrink in old age. This results in significantly decreased need for calories, vitamins, and minerals.

   _____ True _____ False

5. The OAANP serves individuals aged 60 and older. The congregate meal program was established to increase socialization as well as to improve nutritional intakes of older adults.

   _____ True _____ False

6. DETERMINE, MUST, and the MNA are three tools to screen for nutritional risk. List five factors that place older adults at risk of malnutrition.
7. Food guidance for older adults is different from that for the general public. Cite two adjustments in food guidance that are particularly important for older adults.
8. The AMDR for protein is 10–35 percent of calories, and the RDA is 0.8 gm/kg body weight. If the average older adult meets the RDA, why is protein a nutrient of concern for older adults?
9. Using information from Question 8, how would you determine the protein needs of Richard in Case Study 18.1? *Hint:* He weighs 235 pounds (107 kg).

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19

Nutrition and Older Adults

Conditions and Interventions

Prepared by Nadine R. Sahyoun

Learning Objectives

After studying the materials in this chapter, you should be able to:

19.1 Describe key nutritional approaches to the most prevalent chronic diseases of adults 65+, recognizing the heterogeneity of older populations.

19.2 Describe key nutritional approaches to heart disease in adults 65+, recognizing the heterogeneity of older populations.

19.3 Describe key nutritional approaches to addressing strokes and related diseases in adults 65+, recognizing the heterogeneity of older populations.

19.4 Describe key nutritional approaches to hypertension in adults 65+, recognizing the heterogeneity of older populations.

19.5 Describe key nutritional approaches to diabetes in adults 65+, recognizing the heterogeneity of older populations.

19.6 Explain how sarcopenia combined with obesity affects fitness and weight management in older adults.

19.7 Describe key nutritional approaches to osteoporosis in adults 65+, recognizing the heterogeneity of older populations.

19.8 Identify three or more nutritional strategies that contribute to oral health.

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19.9 Describe the three most common GI problems of older adults, along with nutritional management strategies to ameliorate each condition.

19.10 Describe key nutritional approaches to osteoarthritis in adults 65+, recognizing the heterogeneity of older populations.

19.11 Describe key nutritional approaches to cognitive impairment, dementia, and Alzheimer's diseases of adults 65+, recognizing the heterogeneity of older populations.

19.12 Understand how comorbidities and polypharmacy increase nutritional risk in older adults.

19.13 Explain the challenges faced by underweight individuals and the consequences of sarcopenia on day-to-day functioning.

19.14 List three or more signs of dehydration and explain why maintaining hydration status is important for the health of an older person.

19.15 Explain how social support during bereavement can help the survivor to stay healthy.

Introduction: The Importance of Nutrition

The term **healthspan** is joining *lifespan* to focus on what really matters to older adults.[1] Aging adults want to stay **healthy** until death, and most (78 percent of adults aged 65 and over) rate their own health as *good, very good, or excellent*.[2] They believe this despite the increasing prevalence of chronic illness in old age. Having a chronic health problem (Table 19.1) does not prevent someone from having the perception of being healthy. Still, self-perception of good health declines with age. By age 85, self-perceived health status of *good to excellent* decreases to 72 percent of non-Hispanic Whites, 56 percent of non-Hispanic Blacks, and 50 percent of Hispanic or Latino groups.[2] Good nutrition contributes to **quality of life** and ameliorates effects of illness. But illness often brings with it changes in eating pattern, either as a symptom of disease, such as the anorexia associated with depression, or as part of therapy, when avoidance of salt or fatty meats may leave individuals at a loss of how to replace their soup and sandwich lunch with a tasty, low-sodium, low-saturated fat version. **Medical nutrition therapy (MNT)** as part of a comprehensive treatment plan can encourage health-promoting food choices once diseases have been diagnosed. Outcome data regarding the effectiveness of MNT by registered dietitian nutritionists (RDNs) have resulted in reimbursement provided to Medicare Part B beneficiaries with diabetes mellitus and kidney disease,[3] using nationally recognized

healthspan Illness-free life span.

healthy More than the absence of disease, health is a sense of well-being. Even individuals with a chronic condition may properly consider themselves to be healthy. For instance, a person with diabetes mellitus whose blood sugar is under control can be considered healthy.

quality of life A measure of life satisfaction that is difficult to define, especially in an aging heterogeneous population. Quality-of-life measures include factors such as social contacts, economic security, and functional status.

medical nutrition therapy (MNT) Comprehensive nutrition services by registered dietitians to treat the nutritional aspects of acute and chronic diseases.

Table 19.1 Percentage of people aged 65 and older who reported selected chronic conditions, 2017–2018, by sex

Sex	Heart Disease	Hypertension (2015–2018)	Stroke	Cancer (Any)	Diabetes (2015–2018)
Men					
65–74	28.9	66.7	7.5	16.4	
75+	43.2	81.5	13.2	26.0	
Women					
65–74	18.5	74.3	5.9	17.0	
75+	31.0	86.0	10.9	21.2	
					29.0 (age 65+ both sexes)

Source: *Health United States, 2019,* 2021,[14] Tables 13 and 14 (physician-diagnosed and undiagnosed diabetes) and Table 22 (hypertension is defined as having measured systolic pressure of at least 130 mmHg or diastolic pressure of at least 80 mmHg or taking high blood pressure medication).

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nutrition protocols and evidence-based practice guidelines.[4] The most current Medicare rules can be found at the Center for Medicare and Medicaid Services (www.cms.hhs.gov).

Numerous studies have measured the health-care utilization of older adults and found that better nutritional status is related to better health outcomes. The Lewin Group researchers estimated that covering medical nutrition therapy for older managed-care clients who had cardiovascular disease (CVD), diabetes, or renal disease would recover Medicare costs after 3 years and would begin to save system dollars by the fourth year.[5] Malnourished older patients have higher postoperative complication rates and longer hospital stays, therefore incurring greater healthcare costs.[6,7] In free-living older adults, nutritional risk status was found to be the most important predictor of total number of physician visits, visits to physicians in the emergency room, and hospitalization rates.[8] Aging adults use proportionately more health-care services and products than younger persons do; therefore, nutrition interventions can play a larger role in their health.

19.1 Nutrition and Health

The ancient Latin quotation *Mens sana in corpore sano* ("a sound mind in a sound body") is often used to emphasize a whole-body approach to health. Public health professionals monitor health by measuring leading causes of mortality and morbidity in order to design interventions that improve the population's health. Leading health problems and disabilities become the focus of nutritional interventions.

Deaths from heart and **cerebrovascular diseases** have declined (Figure 19.1), but they are still among the leading causes of death of older adults. Among persons aged 65 and older, more die from heart disease than any other cause (Table 19.2).

Table 19.2 Number of deaths in the United States in 2020, by leading causes

Cause of Death	Number of Deaths
Heart Disease	556,665
Malignant Neoplasm	440,753
COVID-19	282,836
Cerebrovascular Disease	137,392
Alzheimer Disease	132,471
Chronic Lower Respiratory Disease	128,712
Diabetes Mellitus	72,194
Unintentional Injury	62,796
Nephritis	42,675
Influenza and Pneumonia	42,511

Source: National Center for Injury Prevention and Control.[9]

Lifestyle interventions have a huge potential to affect premature deaths. The prevalence of multiple chronic conditions increases with age. If you sum the percentages in Table 19.1, you'll note that the total is greater than 100. Common comorbid conditions are hypertension, heart disease, diabetes, cancer, stroke, arthritis, and kidney disease. For example, in 2012, 21 percent of adults over 65 had hypertension and heart disease; 15 percent had hypertension and diabetes, and 11 percent had

cerebrovascular disease Conditions caused by problems that affect the blood supply to the brain.

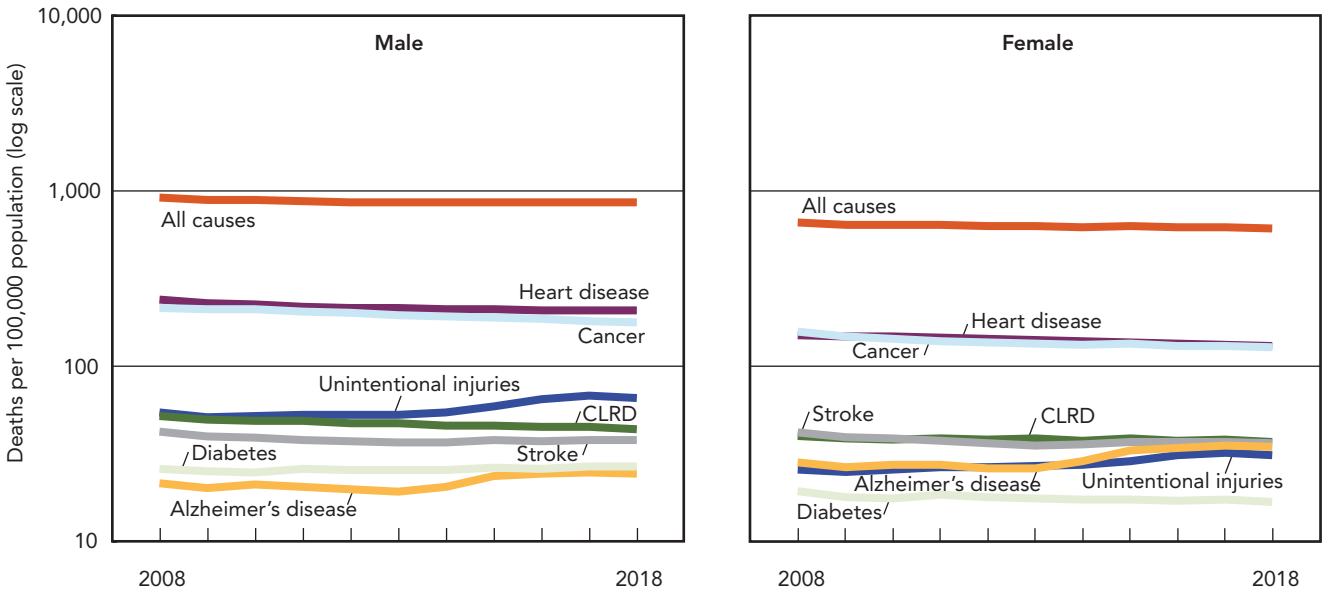


Figure 19.1 Leading causes of death from 2008–2018[14]

Source: National Center for Health Statistics. Health, United States, 2019. Hyattsville, MD. 2021. doi: https://dx.doi.org/10.15620/cdc:100685.[14]

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hypertension and cancer.[10] Despite eating patterns that earn better Healthy Eating Index (HEI) scores than those of younger people, the diets of older adults contribute to the incidence and course of their diseases, especially heart disease, hypertension, and cancer. These diseases can, in turn, affect functional ability. For example, an overweight individual with heart disease may continue to overeat and become obese, further complicating arthritis management. In turn, arthritis can limit functioning. Weight loss of even 1 lb will reduce stress on the knees during daily activities and may also lead to enhanced management of heart disease.[11] Old age is not a reason to forgo health promotion. The Physician's Health Study examined modifiable risk factors contributing to survival and optimal functioning of men at age 90 and beyond. Good health habits (not smoking, moderate alcohol intake, not becoming obese, and regular physical exercise) contributed to delayed mortality and to higher functional status in old age.[12] An analysis of the dietary habits of postmenopausal women with established heart disease (mean ages of study's three groups: 64.1, 66.3, and 66.6 years) assessed how closely food intake met the 2005 Dietary Guidelines for Americans. Using a scoring tool that was weighted for heart health risk showed that women with diets most closely resembling the dietary guidelines had a slower rate of atherosclerosis progression over the 3.3-year period of follow-up.[13] Much of the research literature deals with contributions of nutrition to heart health because that is the leading, modifiable, disease in older adults. Healthy People 2030 goals (Table 18.2) that are especially applicable to older adults with medical conditions are to maintain physical activity for muscle strength, to reduce obesity, and to increase total vegetable consumption. This chapter addresses the role of nutrition as a factor in disease prevention, treatment, and recovery of overall health in adults aged 65 and older.

19.2 Heart Disease

For a disease with modifiable risk factors, heart disease is still the leading cause of death in older adults and the leading cause of their hospitalizations. The adult risk factors and course of heart diseases were discussed in Chapter 17. Specifics for older adults are highlighted in this section, including stroke and hypertension.

Prevalence

Cardiovascular disease (CVD), which includes coronary heart disease, heart failure, stroke, and hypertension, rises with age. Heart disease prevalence varies by age, race, and sex.[14] It is more prevalent among men and non-Hispanic Black people. The American Heart Association (AHA) publishes updated statistics on the prevalence of CVD. After age 80, less than 11 percent of men and 10 percent of women are free of heart disease with hypertension.[15]

Risk Factors

Risk factors for CVD in old age remain the same as in younger adults, except that the factors have less predictive value in old age.[16] Results of a study by Odden and colleagues supported by findings from other studies, indicated that elevated LDL cholesterol and obesity were not associated with cardiovascular events in persons older than 65 years. Also, elevated systolic blood pressure and low HDL cholesterol were associated with cardiovascular events only in persons <85 years. Other emerging risk factors such as kidney function, diabetes, inflammation, and cardiac strain (cardiac contractility) were better predictors of cardiovascular events in older adults. The authors suggest that these risk factors may capture lifelong insults to the cardiovascular system and may be better measures of cardiovascular disease events.[16] This is an ongoing and active area of research. Eating a Mediterranean-style diet is associated with lower CVD mortality, as is engaging in physical activity and not smoking. Fewer than 9 percent of adults age 65 and over are current smokers.

Nutritional Remedies for Cardiovascular Diseases

Assertive treatment can modify the course of heart disease at any age, although an older adult is more likely to have comorbid conditions that necessitate balancing multiple goals. Together, the older adult and their health-care providers can develop a treatment plan that balances health and quality-of-life goals.

Basic questions address an individual's motivation to adopt and maintain heart-healthy routines. The individual may be wondering whether potential health gains are worth the necessary changes. Is the individual balancing quality of life with potential life expectancy? For individuals who are new to cooking or have become bored with it, are there classes that demonstrate how to prepare whole grains, cook new vegetables, or find ways to add fish into a meal plan? Will the budget support buying additional fruits and vegetables and eating at restaurants that offer more heart-healthy choices? If function is limited, what are the resources available to build a sustainable exercise routine? Is the person willing to ask for and accept assistance if needed to shop for groceries or to prepare meals? Can the individual maintain heart-healthy habits when eating with family and friends, at home, or in restaurants? The nutrition interventions that support heart health are not inherently different for an older adult than for a younger one. But the day-to-day context for adopting therapeutic lifestyle changes is likely different for an 80-year-old than for a 45-year-old. An individual's view their own physical and emotional status is an integral part of how treatment will be pursued and how heart-healthy habits will be maintained. Nutritional habits alter

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the progression of atherosclerosis only if an individual adheres to the eating plan.

In 2019, the American College of Cardiology (ACC) and American Heart Association (AHA) released Guidelines on the Primary Prevention of Cardiovascular Disease, which are based on thorough evidence-based review of the literature that provided 10 take-home messages.[17] One of these messages recommends consuming a healthy diet that includes fruit, vegetables, nuts, whole grains, lean vegetable or animal protein and fish, and minimizing the intake of *trans* fats, red meat and processed red meats, refined carbohydrates, and sweetened beverages. This guideline also specifies reducing salt and cholesterol intake and replacing saturated fat with dietary monounsaturated and polyunsaturated fat. There is inconsistent evidence linking dietary cholesterol to LDL and, therefore, there is no explicit numerical recommendation for it except to state that dietary cholesterol should remain low. Consuming the recommended dietary pattern summarized in the *2021 Dietary Guidance to Improve Cardiovascular Health* and in the *2030 Dietary Guidelines for Americans* will result in a healthy diet with low levels of dietary cholesterol.[17,18]

Consumption of fish, fish oils, and omega-3 polyunsaturated fatty acids is also of interest to older adults because these are marketed to improve memory and alleviate depression as well as reduce heart disease. However, a meta-analysis of omega-3 fatty acid supplement use found no significant association with fatal or nonfatal coronary heart disease or any major vascular events.[19] Similarly, the relationship between fish oil, memory, and depression are inconclusive. Until further information is available, two servings of fatty fish per week (cold-water or marine fish) are recommended, in part, to replace red meat.[20]

Another recommendation by the 2019 AHA/ACC stressed the importance of regular physical activity. The guidelines state that adults should engage in at least 150 minutes per week of accumulated moderate-intensity or 75 minutes per week of vigorous-intensity aerobic physical activity (or an equivalent combination of moderate and vigorous activity) to reduce CVD risk.[17] However, older adults unable to meet these recommendations would still benefit by engaging in some physical activity.

19.3 Stroke

AHA and the American Stroke Association describe both stroke and **transient ischemic attacks (TIAs)** as serious conditions involving reduced cerebral blood flow (brain **ischemia**); both are markers for increased risk of disability and death.[21] TIAs, brief episodes of neurological dysfunction such as sudden confusion, trouble speaking or understanding, or sudden dizziness and difficulty in walking, often precede a stroke. During an ischemic stroke (about 85 percent of all strokes), an obstruction clogs a blood vessel and prevents oxygen and other nutrients from reaching part of the brain. A hemorrhagic stroke occurs when a weakened blood vessel breaks, such as the rupture of an **aneurysm**. Leaking blood accumulates, putting pressure on the surrounding tissue and eventually destroying brain cells.

Prevalence

Of adults aged 65 and older, 10 percent of males and 8 percent of females had a stroke in 2018, but females have a greater lifetime risk.[2] At ages 60–79, incidence of stroke is higher for men than women, but by age 85, incidence is greater for women. In the United States, the Black population is at higher risk of stroke compared to other racial/ethnic populations although this depends somewhat on the type of stroke. For example, age-adjusted first-ever ischemic stroke rates per 1,000 occur at the rate of 1.91 in Black people, at 1.49 in Hispanics, and 0.88 in White people.[15] Strokes have serious potential to affect the lifestyle and nutritional behaviors of survivors. Among individuals having a first stroke at age 65 or older, 13 percent die within 1 month. Six months after a stroke, 35 percent of survivors had depressive symptoms, 30 percent needed some assistance walking, 26 percent were institutionalized in a nursing home, and 19 percent had **aphasia (unable to speak)**.

Etiology

Factors that can lead to a stroke include blocked arteries (by a **thrombus** or **cerebral embolism**), easily clotting blood cells, and weak heartbeats that are unable to keep blood circulating through the body, allowing pools of blood to form and clot. Hypertension contributes to strokes because the force of blood may break weak vessels.

Effects of Stroke

Strokes deprive the brain of needed oxygen and other nutrients, causing brain and nerve cells to die. As a result, stroke leads to loss of function for parts of the body controlled by the oxygen-deprived cells. For example, stroke victims' bodies may become paralyzed in either the left or the right side, or they may become unable to speak (aphasia), walk, or swallow. Nutrition is likely to be affected in the stroke aftermath. Quick recognition of stroke results in faster treatment and better recovery. Although dead brain cells cannot be replaced, new nerve pathways can develop

transient ischemic attacks (TIAs) Temporary and insufficient blood supply to the brain.

aneurysm Ballooning of the blood vessel wall.

aphasia Difficulties in self-expression, including inability to speak, finding the right words, or understanding print or spoken words.

thrombus Blood clot.

cerebral embolism Piece of a blood clot formed elsewhere that travels to the brain.

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in the gray-matter reservoirs of the brain. The ability to develop new neural pathways provides hope for successful rehabilitation therapies. Relearning how to feed oneself, how to chew, and how to swallow may well be a part of the slow, arduous process of rehabilitation.

Risk Factors

Geography seems to be a risk factor for increased mortality from stroke; the southeastern part of the country is considered the stroke belt, death rates are 30–40 percent higher here than in the rest of the country.[15] A study funded by the National Institute of Health named Reasons for Geographic And Racial Differences in Stroke (REGARDS) attempts to identify the reasons for this geographical disparity. Part of the answer is attributed to the usual risk factors such as hypertension, diabetes and the lifestyle factors, diet, and smoking; however, these do not appear to completely explain the discrepancy. Research is ongoing to examine genetic and other lifestyle factors.[22] A strong predictor for incurring a stroke is age. Young adults rarely have strokes. In the 18- to 24-year-old age group, 0.1 percent had a stroke in 2017–2018 and 0.8 percent of those aged 25–44. Stroke prevalence rises sharply in older age to 11.9 percent for those aged 75 years and older. This risk of having a stroke is almost twice that of adults aged 65–74 years.[14] The additional presence of multiple chronic conditions complicates stroke prevention. The following factors place an individual at higher risk for stroke:

- Long-term high blood pressure (either systolic or diastolic)
- Family history
- African American, Asian, and Hispanic ethnicity
- Physical inactivity
- Cigarette smoking (doubles the risk of ischemic strokes)
- Comorbid conditions, including diabetes mellitus, **carotid artery disease**, **atrial fibrillation**, TIAs, sickle cell anemia, and depression
- Living in poverty
- Excessive use of alcohol; use of cocaine and illicit intravenous drugs

The role of alcohol is complex and controversial. It was believed that moderate amounts of any type of alcohol could be protective against stroke, while excessive amounts increase stroke risk significantly.[23] However, a study published in *The Lancet* of over 500,000 men and women in China showed that any amount of alcohol intake does not protect against the risk of a stroke.[24]

carotid artery disease Arteries that supply blood to the brain and neck becoming damaged.

atrial fibrillation Degeneration of the heart muscle causing irregular contractions.

Nutritional Remedies

Stroke prevention programs for older adults tend to be secondary or tertiary rather than primary. In the United States, not enough resources are allocated to prevention programs and the emphasis has been on treatment and rehabilitation. However, this is slowly changing. A review of dietary patterns resulting in reduced risk of stroke found increasing fruit and vegetable intake (especially cruciferous ones) to be an effective strategy of primary stroke prevention.[25] These dietary eating patterns—which include the Prudent Pattern, the DASH diet, and the Mediterranean Diet—were all correlated with reduced stroke incidence. The focus of dietary advice in stroke prevention is to normalize blood pressure and follow healthy lifestyle habits, which is discussed with hypertension. Individualized medical nutritional therapy is used to promote rehabilitation after a stroke.[25]

19.4 Hypertension

High blood pressure (HBP) is a risk factor for CVD and stroke and a leading risk factor for mortality and disability. The definition of HBP in older adults has changed over time. In the "2014 Evidence-Based Guideline for the Management of High Blood Pressure in Adults" report, the blood pressure treatment initiation and goal attainment threshold for individuals aged 60 years and older, without diabetes or chronic kidney disease, was raised to 150 mmHg systolic blood pressure and 90 mmHg diastolic blood pressure.[26] However, new guidelines released in 2017 by the ACC and the AHA recommend a systolic blood pressure goal of less than 130 mmHg and a diastolic goal of less than 80 mmHg for adults aged 65 and over. Initiation of treatment is recommended for those with systolic or diastolic pressures higher than these recommended levels who have comorbidities such as diabetes and chronic kidney disease. Nonpharmacologic interventions are considered effective at lowering blood pressure in healthy adults. For adults aged 65 years and over with a high burden of comorbidities and limited life expectancy, clinical judgment is required in the choice of hypertensive drugs and in the intensity of blood pressure lowering.[27]

Prevalence

Hypertension (HBP), defined here as over 130 mmHg systolic blood pressure or 80 mmHg diastolic blood pressure, is the only chronic condition that has higher prevalence in older adults than arthritis (Table 19.1). In Western societies, prevalence rises with age. An individual who controls HBP with medication is still considered to have hypertension, because a controlled disease is still there. Before age 65, a higher proportion of men than women

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have HBP; then the percentages become higher in women. Death rates from HBP vary by race and are more frequent among the Black than the White population. For example, in 2015, mortality rates were 2.2 times higher in non-Hispanic Blacks than in non-Hispanic Whites. There has been considerable improvement in awareness, treatment, and control of hypertension; however, undiagnosed and uncontrolled hypertension among underserved populations remain a challenge. In 2011–2014, 84.1 percent of hypertensives were aware of their hypertension, 76.0 percent reported being under treatment to lower their blood pressure, and 54.4 percent had their blood pressure controlled.[27,28]

Etiology

For most adults, blood pressure tends to develop over many years, and there are no identifiable causes. It has been shown that family history and ethnic background increase the risk of hypertension, however, the genetic basis of hypertension and the gene/environment interaction that may lead to elevated BP is still unknown. Salt intake is a major contributor to hypertension although the exact mechanism is unclear.[29]

Effects of Hypertension

Prolonged HBP puts extra tension on blood vessels and organs in the body, wearing them out before the natural aging process. Damaged kidneys are a common sign of uncontrolled hypertension. HBP also increases the risk of CVD for millions of people worldwide.

Risk Factors

A number of factors increase blood pressure, such as drinking too much alcohol, high salt intake, obesity, high-saturated-fat diets leading to dyslipidemia and atherosclerosis, physical inactivity, smoking, and a diet low in calcium and potassium.[30]

Nutritional Remedies

Nutritional strategies to normalize blood pressure include weight management, moderation of alcohol intake for those who drink, and limiting sodium intake while maintaining adequate potassium, magnesium, and calcium intakes. Also, the consumption of dietary patterns such as the DASH diet (Tables 19.3 and 19.4) is effective in decreasing blood pressure.[31,32] Other nondrug interventions such as using weight reduction and/or sodium restriction of 1,500–1,800 mg per day over 30 months have successfully lowered the blood pressure.[33] This sodium level is well below average intakes (Table 18.11).

Blood pressure reduction occurred whether individuals were normotensive or hypertensive.[34] Choosing foods with less processing can help limit sodium intake, because approximately 75 percent of dietary sodium is attributable to manufacturing and preservation processes, with salt at the table contributing the rest. For instance, the sodium in a plain potato averages 10–15 mg, compared to 150–200 mg sodium in a serving of potato chips.

Table 19.3 DASH effectiveness increases as sodium decreases, but it's not easy to consume <1,500 mg

Food Group		MG Sodium
6 Grains	Raisin bran cereal (1 cup = 2 svgs)	237
	Whole wheat bread (2 slices = 2 svgs)	324
	Pasta, cooked without salt (1 cup = 2 svgs)	325
4 Vegetables	Steamed asparagus (1 cup = 2 svgs)	5
	Lettuce (1 cup)	7
	Cherry tomatoes and baby carrots (5 each)	46
4 Fruits	Dried cherries (¼ cup)	0
	Mixed fresh fruit (1 cup = 2 svgs)	10
	Banana or apple (1 med)	1
2–3 Dairy	One percent milk (1 cup)	95
	Plain Greek yogurt (6 oz)	58
	Cheese (1 oz)	186
Meats, fish	Fried catfish, 3 oz	353
Nuts	Pecans (20 halves) or 24 almonds	0
2 Fats, Oils	Unsalted butter (1 tsp)	1
	Salad dressing (2 Tbsp regular Italian)	292

Source: USDA Food Composition Databases. Available at https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/food-surveys-research-group/docs/whats-in-the-foods-you-eat-search-tool/, accessed March 20, 2022.

Effectiveness of the DASH eating plan has been tested in various settings. For example, a cardiovascular health-center team, including a dietitian, used a modified DASH approach combined with exercise to help patients in an outpatient, office-based counseling program.[34] The team saw patients (aged 55, plus or minus 12 years) for CVD and weight loss. Patients had significant weight loss (5.3 percent of body weight) that was maintained for the 2.6 years of study follow-up. Diastolic blood pressure reduction was also significant, although systolic pressure reduction was not. Several DASH-adherence scoring systems are available and useful to compare research that use DASH eating patterns as intervention. Folsom's study of CVD mortality and hypertension in nearly 21,000 women found no statistically significant outcomes using a DASH concordance score.[35] In contrast to Folsom's study, Levitan and colleagues compared four scoring methods and found that following the DASH diet led to decreased heart failure for middle-aged and older women (48–83 years old).[36] The women most closely following the DASH diet (the top quartile of diet scores) had a 37 percent lower rate of heart failure than the lowest-scoring quartile in the 7-year-long study.

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Table 19.4 The DASH eating plan for blood-pressure control in older adults

	Servings Per Day	Serving Sizes of Foods Within the Food Group
Grains and Grain Products Especially whole grain[a]	6–8	Breads: 1 slice or 1 oz Cereal: ½ cup cooked or dry Rice, pasta: ½ cup cooked
Vegetables Fresh, frozen, no-salt-added canned	4–5	Raw, 1 cup; cooked, ½ cup
Fruits Fresh, frozen, or canned in juice	4–5	Juice: 6 oz Fresh: 1 med piece Mixed or cut: ½ cup Juice: 6 oz Dried: ¼ cup
Dairy Foods Skim or 1% milk, fat-free dairy products	2–3	Milk: 8 oz Yogurt: 1 cup Cheese: 1½ oz
Meats, Poultry, and Fish	Up to 2	3 oz, cooked
Nuts, Seeds, Dry Beans	4–5 per week	⅓ cup or 1½ oz nuts 2 Tbsp or ½ oz seeds 2 Tbsp nut butter ½ cup cooked beans (legumes)
Fats and Oils[b] Select olive, canola, corn, and safflower oils	2–3	1 tsp butter, oils, mayonnaise 2 Tbsp salad dressing
Sweets	Up to 5 per week	1 Tbsp jam, jelly, syrup, or sugar ½ cup sorbet, gelatin

[a] Whole grain is the entire edible part of wheat, corn, rice, oats, barley, and other grains. Whole-grain bread has the words *whole grain* before the type of flour that is listed; whole-grain breakfast cereals include the word *whole* or *whole-grain* before the grain name (e.g., *whole-grain wheat*).

[b] One serving is equivalent to 5 g of fat.

Source: Adapted from 2000-calorie DASH eating plan. National Heart, Lung, and Blood Institute. Available at https://www.nhlbi.nih.gov/education/dash-eating-plan, accessed March 21, 2022.

The DASH diet is one of the meal plan options in dietary guidance materials because it is considered to be health-promoting for the general public as well as for people with hypertension. Dietary and lifestyle changes that address hypertension are also likely to have a beneficial effect on atherosclerosis.

19.5 Diabetes: Special Concerns for Older Adults

In the National Health and Nutrition Examination Survey (NHANES) 2015–2018, 29 percent of adults aged 65 years and older had diagnosed and undiagnosed diabetes, primarily type 2 (Table 19.1).[14] Asians, non-Hispanic Blacks, and Hispanic older adults face higher risks for diabetes than do non-Hispanic Whites.[14,37]

Individuals with diabetes are at greater risk of premature death, and of comorbid conditions such as hypertension, coronary heart disease, and stroke, than those without diabetes. Diabetes itself is an independent risk factor for atherosclerosis. This complicates diabetes management.

glycosylated hemoglobin A1C (HbA1c) A blood test that measures how well the blood sugar level has been maintained over the last 2 to 3 months.

Diabetes diagnosis criteria and management goals are the same for older as for younger adults, using individualized treatment plans that include assessment of functional status, cognitive capacities, and motivation.[38] However, the 2017 standards of medical care issued by the American Diabetes Association (ADA) recommend that **glycosylated hemoglobin A1C (HbA1c),** the measure of glycemic control, varies according to the health status of older adults. While HbA1c of <7.0 percent is the recommended level for healthy younger adults, the recommendation is to relax the guidelines to fit older individuals who can't achieve tight control with simple measures. A reasonable HbA1c goal for healthy adults aged 65 and older is <7.0–7.5 percent; however, for those older adults with advanced diabetes complications, life-limiting comorbid illness, or substantial cognitive or functional impairment, a less-intensive glycemic target goal of HbA1c <8.0 percent is recommended.[39] Factors that may prevent an individual from achieving tight control are use of medications that increase risk of hypoglycemia, declining cognitive function or capacity for self-care, depression, and lack of a strong support system. However, old age alone

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is no reason to curtail care; the ADA guidelines emphasize that risk of complications from hyperglycemia should be avoided in all patients and screening for diabetes complications is essential to prevent functional impairment.[39]

Effects of Diabetes

Diabetes leads to a tenfold greater risk of amputations, macular degeneration, visual loss, cataracts, glaucoma, and neuropathies (nerve damage, pain, or tingling) of the hands and feet. Hyperglycemia may lead to sodium depletion and dehydration, trace mineral depletion (zinc, chromium, magnesium), insomnia, nocturia, blurred vision, increased platelet adhesiveness related to atherosclerosis, increased infection and decreased wound healing, and aggravated peripheral vascular disease. In older adults, diabetes may exacerbate declining organ functions, making them less resilient.

Alcohol and drugs such as salicylates (aspirin) contribute to drops in blood sugar. Hypoglycemia in older adults may lead to weakness, confusion, and possible falls and fractures. Other reasons for falls include declining vision and nerve function. For example, in the Health, Aging, and Body Composition[39] study of older adults with diabetes, 22–31 percent of participants reported falling in a 12-month span. Mean age at study enrollment was 73.6 years and falls increased as participants aged. In each subsequent year of the study, the percentage of participants who self-reported falls increased (from 22 percent, to 26 percent, 30 percent, and 31 percent at study end). Individuals were at higher risk of falling if they had reduced peripheral nerve function, renal function, and vision; all are diabetes complications.

Nutritional Interventions

One outcome of increased life spans is that older adults with diabetes now have more years to maintain desired quality of life and avoid complications. Therefore, self-management education and support are critical to preventing complications. Diabetes self-management training, to the extent that the individual is able to manage their own regimen, works in tandem with medical nutrition therapy and lifestyle modifications to achieve glycemic control. Special concerns for older adults include the following:

1. *Carbohydrate and fiber recommendations do not change for old age.* There is no ideal carbohydrate intake level for persons with diabetes. The primary goal is to maintain a consistent carbohydrate intake (Table 19.5) and monitor blood glucose response.[40] Some individuals benefit from carbohydrates with low glycemic index scores, but the most effective glycemic control at any age begins with an individualized meal plan. Carbohydrate intake should emphasize nutrient-dense carbohydrate sources with at least 14 g fiber per 1,000 kcal and minimally processed. Eating plans should emphasize nonstarchy vegetables, fruits, and whole grains, as well as dairy products, with minimal added sugars. Also include foods rich in long-chain n-3 fatty acids, such as fatty fish (EPA and DHA) and nuts and seeds. Individuals could benefit from following the Mediterranean, DASH, or Prudent pattern–type diet.
2. *For people with diabetic kidney disease,* it is not recommended to reduce the amount of dietary protein below the recommended daily allowance

Table 19.5 Comparison of cereal grain nutrients, including glycemic index, ½ cup cooked portion

Grain, 5 Cups Cooked	Kcal	G Carb	G Fiber	G Pro	G Fat	Mg Calcium	Mg Magnesium	Glycemic Index
Amaranth	129	23	2.3	4.7	2.4	58	87	74
Barley	96	21	4.3	2.7	0.3	9	22	35
Brown rice	108	22	2.8	2.5	0.9	10	42	50
Corn/grits/polenta	75	16	0.8	1.4	0.3	4	8	68
Farina, cream of wheat	61	13	0.6	1.7	0.2	105	6	51
Oatmeal, steel-cut	101	18	2.7	3.5	1.7	21	39	49
Quinoa	113	20	2.1	4.3	1.8	16	61	53
Teff	126	25	2.7	4.5	0.8	64	64	45
Rolled wheat	69	15	1.9	2.3	0.4	11	26	45
Wild rice	83	17	1.5	3.3	0.3	2	26	50
Compare protein:								
Small egg	59	.4	0	4.8	4	19	4	0
Peanut butter, 1 Tbsp	95	3	1	4.0	8.1	7	25	35

g, gram; mg, milligram; Glycemic index: Glucose, 100.

Source: Nutrition Data System for Research 2011, University of Minnesota.

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(0.8 g/kg/day based on ideal body weight) because "it does not alter glycemic measures, cardiovascular risk measures, or the rate at which glomerular filtration rate declines."[41]

3. *Supplementation with vitamins, minerals, herbs, or spices (such as cinnamon or aloe vera)* ***shows no clear evidence in*** *improving* outcomes in people with diabetes who do not have underlying deficiencies, and they are not generally recommended for glycemic control. Routine antioxidant supplementation (vitamins E, C, and beta-carotene) is not recommended due to a lack of evidence of efficacy and concerns about potential harm.
4. *Monitor functional status and modify the care plan as appropriate for the psychosocial and physical needs of an aging individual.* For example, based on 2010–2018 data of the National Health Interview Survey, 2.5 percent of men and 3.5 percent of women aged 65 and over had a lot of trouble hearing or couldn't hear at all, so eliciting feedback about a client's understanding during a counseling session is worth the extra time required. Also, many older adults have trouble seeing; 2.5 percent of men and 3.6 percent of women aged 65 and over reported a lot of trouble seeing or unable to see (even with glasses or contacts).[2] Carbohydrate counting requires vision to read labels and cognitive ability to track carbohydrate grams. Glycemic management in older adults may be harder to achieve due to altered senses; decreased mobility; difficulty in buying, preparing, or eating food; and depression, all of which may result in muscle loss from missed exercise or increased sedentary behaviors.
5. *Ask about special foods and alternative and complementary therapies.* Evening primrose oil, milk thistle, fenugreek seeds, bitter melon, and prickly pear cactus leaves (nopales) are foods used by certain population groups as botanical treatments. Safe complementary nutritional remedies can enhance the standard nutritional therapies. However, there is insufficient evidence to support the use of certain herbs and supplements in treating diabetes. These must be clarified with the individual.
6. *Sugar alcohols (e.g., xylitol, sorbitol) in candies and gums are sweeter than sucrose and fructose and have fewer calories per gram.* Use of nonnutritive sweeteners (stevia, sucralose, saccharin, aspartame) can help reduce total energy intake and aid in weight management. Although these polyols provide fewer calories, they are not totally calorie-free foods and the food labels should be checked. High doses of some of these sweeteners often lead to diarrhea.

19.6 Obesity

Definition

The National Heart, Lung, and Blood Institute guidelines[41] and the World Health Organization (WHO)[42] define obesity as a BMI of 30.0 or higher, and extreme obesity as a body mass index (BMI) of 40 or higher. These definitions are intended for adults of all ages. However, the underlying research for BMI cut-points relied primarily on young and middle-aged populations.[43] In older adults, BMI alone is not an adequate indicator of excess body fat associated with morbidity and mortality.

Prevalence

Body composition changes with age. Population mean body weight and BMI tend to peak around age 60 and decline after age 70,[44] although the girth of the average older adult has grown along with that of the rest of the country (Table 19.6).[14] Age-related changes in weight and BMI can mask fat gain and muscle loss. Fat-free mass decreases with age while body fat increases. Body fat is redistributed with an accumulation in the visceral (intra-abdominal) region, especially in men and intramuscularly, weakening the structure of the muscles. Therefore, determining what is healthy weight or body composition in older adults is very complex.

Etiology, Effects, and Risk Factors of Obesity

The relationship between obesity, morbidity, and mortality in older adults is complicated. Overweight and obesity are associated with functional decline, higher disability, and higher risk of chronic conditions such as diabetes, hypertension, and stroke.[44] However, the relationship between obesity and mortality is inconclusive. This is, in part, because BMI, which does not reflect the proportion of lean muscle mass and body fat, has been used to assess body composition of older adults. Optimum BMI cut-points for older adult populations are in a U-shaped curve, and the range of BMIs associated with good health and functional status are not necessarily the same as those for lowered mortality risk. Research studies and meta-analysis showed that the BMI associated

Table 19.6 Percent obesity (BMI >30) in older adults in 1999–2002 and 2009–2012 NHANES data

Age	Males		Females	
	2011–2014	2015–2018	2011–2014	2015–2018
65–74	36.2	41.9	40.7	45.9
75+	26.8	31.8	30.5	36.1

Source: *Health United States, 2019,* 2021,[14] Table 26.

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with the lowest mortality falls within the overweight range and mortality increased at BMI 35 and higher[45] or at BMI over 33.[46] For older adults, extra weight during illness episodes, especially hospitalizations, seems to be protective.

Using BMI to define obesity in older adults comes with so many caveats (difficulty in measuring height, shrinking height, shifts in body composition from youth, hydration status) that assessment will be more meaningful when using BMI in conjunction with more reliable measures of excess body fat. Two large longitudinal studies that followed populations consisting of,[47] or including,[48] older adults suggested that abdominal obesity is a better measure of premature death than BMI. An exploration of obesity as a risk factor for stroke and transient ischemic attacks found that markers of waist circumference, waist-to-stature ratio, and waist-to-hip ratio predicted stroke cases better than BMI (Figure 19.2).[49] Unintended weight loss is also a good predictor of higher mortality. Weight gain or loss as measured by changes in BMI often serve as an initial estimate for health and fitness, awaiting elaboration with a more detailed nutrition assessment. Therefore, interpretation of BMI should be in the context of health status and functional capacity. There have been also controversies on determination of the lower BMI cut-points. The results of a 2014 meta-analysis showed that the risk of mortality in older adults increased with a BMI of <23.0 and the lowest risk of mortality was BMI 24.0–30.9.[49] In younger adults, BMI <18.5 is considered underweight.[44] Refer to Table 19.7 for a compilation of BMI ranges suggested for use with older adults.

In older populations' health, fitness plays an essential role. One can maintain weight while losing muscle and organ tissue, resulting in **sarcopenia** and declining

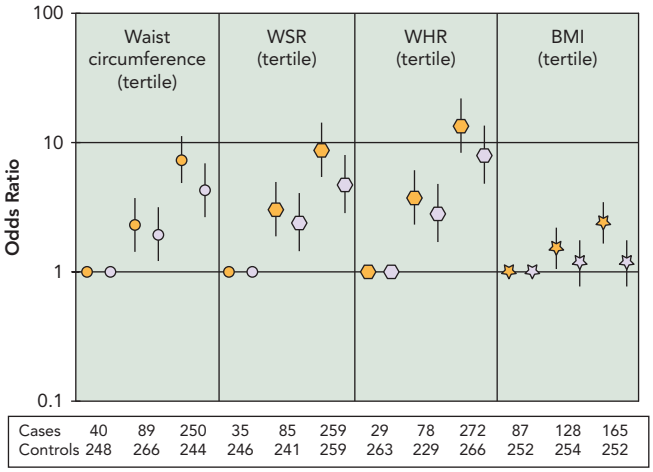


Figure 19.2 Association of markers of obesity with risk of stroke and TIA.

Note: WSR: Waist-to-Stature Ratio; WHR: Waist-to-Hip Ratio; TIA: Transient Ischemic Attack; Vertical bars indicate 95 percent Confidence Interval.

Source: Winter, Y., Rohrmann, S., Linseisen, J., Lanczik, O., Ringleb, P. A., Hebebrand, J., & Back, T. Contribution of obesity and abdominal fat mass to risk of stroke and transient ischemic attacks. *Stroke*. 2008; 39(12):3148.

function. In 2018, about 16 percent of adults aged 65 and over found it difficult or impossible to walk a quarter of a mile or to climb up 10 steps without resting.[2] Feeling weak is likely to contribute to reduction in aerobic and strength-building activities. An example of how cardiorespiratory fitness contributes to longevity comes from the Aerobics Center Longitudinal Study, in which 2,603 adults with a mean age of 64 years were followed for 12 years.[50] Fit individuals, even with a BMI of 30–34.9, had greater longevity.

A consensus is still lacking on the definition of obesity in older adults and criteria for evaluating and treating

Table 19.7 BMI values suggested for use with older adults

Screening/Assessment Tool or Researcher	BMI (kg/m²) That Represents Smallest Risk of Malnutrition	Comment
Mini Nutritional Assessment (MNA), refer to Figure 18.3	≥23.0	"Obese" does not generate higher risk scores; tool developed by Nestle Nutrition Institute
Malnutrition Universal Screening Tool (MUST), www.bapen.org.uk/screening-and-must/must/must-toolkit	>20.0 and no recent weight loss	A BMI of 30.0 or greater does not generate a higher risk score; developed for use in communities and long-term care settings
Nutrition Screening Initiative (NSI), Physician's Guide to Nutrition in Chronic Disease Management	22.0–27.0	Developed by American Academy of Family Physicians, the NSI and ADA; partly funded by Ross Products, Abbott Laboratories
G. M. Price et al.[48]	Assess diet and health status when BMI <23.0 in men and <22.3 in women	At age 75 or older, use waist-to-hip ratio
K. M. Flegal et al.[46]	18.5 to <35.0	Body mass index associated with lowest mortality
J. E. Winter[47]	24.0 to 30.9 Monitor weight status at BMI <23.0	Body mass index associated with lowest mortality Mortality started to increase at BMI 33.0

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obesity. High values of waist circumference alone or in conjunction with BMI may be a better definition of obesity in this population; however, waist circumference cutoff points also need to be further evaluated. The 2013 task force for the management of overweight and obesity in adults determined that there were not enough data available to make a recommendation on healthy BMI in older adults or even on strategies and prescriptions for weight loss.[42]

Nutritional Remedies

Weight loss in obese older adults can improve functional status and chronic disease symptoms, but it needs to occur while maintaining muscle and organ tissue.

Sarcopenic obesity may complicate intentional weight loss in older adults. Body weight lost contains more lean tissue than body weight regained, resulting in ever-increasing levels of body fat. In a study of postmenopausal women, 0.26 kilogram (kg) lean was lost for every kg of fat; regained weight was composed of 0.12 kg lean for each kg of fat.[51] Weight loss in individuals with obesity can be harmful if there is no plan for preventing regain or for maintaining muscle and organ mass. A healthy eating program is based on sufficient nutrient-dense calories to support a gradual loss of fat and minimize bone or muscle tissue loss. Weight management was discussed in earlier chapters; a balance of servings from basic food groups, such as outlined in the MyPlate, the DASH eating patterns, or the Mediterranean diet, can promote health in older as well as younger adults. Comorbidities in older adults may require the help of a registered dietitian to balance various nutrition priorities, such as sodium, protein, and saturated fat restrictions when HBP and kidney disease complicate diabetes in an obese individual.

Physical activity promotes functional independence. Physical activity, especially resistance exercise or strength training, is the only way to prevent muscle loss.[52] Functional limitations need not be barriers to exercise. Physical therapists and community and seniors' centers can be helpful resources to develop and promote special routines using chairs, a pool, and adaptive tools. Generally, the best approach is to prevent weight gain from middle-age to older age. Also, recent recommendations suggest that older adults with obesity should focus on weight maintenance rather than weight loss and participation in a combination of aerobic and resistance exercise to improve function.[53]

sarcopenic obesity Low lean body mass combined with excessive fat stores.

telopeptides Molecules that degrade the major collagen of tendon and bone and leave carbon and nitrogen fragments in blood and urine.

19.7 Osteoporosis

Definition

Osteoporosis means "porous bone." Disruption of bone architecture and reduced bone mass can result from an imbalance of available nutrients, shifts in hormones, or both. Osteoporosis progression depends on the homeostatic mechanism involved. An accelerated phase of bone loss occurs due to estrogen or testosterone loss. Bone mass loss is greater for women, who can lose up to 20 percent in the first 5–7 years postmenopause.[54] However, after age 65, the rate of loss slows to less than 1 percent per year. Men develop osteoporosis later than women because they have larger frames, and their testosterone levels fall more slowly. However, in males with prostate cancer, bone mass losses double when androgen deprivation is initiated.

The WHO criteria for bone mass density [BMD, based on measures such as dual-energy X-ray absorptiometry (DXA) scans] are used worldwide to diagnose osteoporosis. BMD that falls 2.5 or more standard deviations below values for healthy young adults denotes osteoporosis.[55] BMD that is 1–2.5 standard deviations below the adult normal is diagnosed as low bone density (osteopenia) and increases fracture risk.

A DXA measures bone mass or density. However, bone tissue is not static. In order to measure the effect various nutrients or medications have on the constant remodeling of bone, researchers are developing biochemical markers to predict age- and menopause-related bone turnover and the risk for fracture. For example, two bone resorption measures involve cross-linked **telopeptides** of type 1 collagen (the major collagen of bone and tendons). These molecules split carbon and nitrogen terminals from collagen chains, resulting in elevated levels of serum C-telopeptide and urinary N-telopeptide. Telopeptide excretion is reported as a ratio to creatinine. Both serum and urine telopeptides are elevated in osteoporosis, rheumatoid arthritis, and bone cancer. Levels decline after treatment with antiresorptive medications. Bone formation can be measured by serum bone-specific alkaline phosphatase, osteocalcin tests and aminoterminal propeptide of type I procollagen.[56]

Prevalence

Prevalence of osteoporosis varies by age and ethnicity. For every one man diagnosed with osteoporosis, four women have the disease. The prevalence of osteoporosis ranged in men from 3.3 percent (age 50–64) to 5.7 percent (age 65+) and in women 13.1 percent (age 50–64) to 27.1 percent (age 65+).[57] Low bone mass affects 51.5 percent of women and 33.5 percent of men. Prevalence rates for osteoporosis are elusive because osteoporosis has no symptoms, such as feeling one's bones becoming weaker. Diagnosis relies on BMD measurement or fracture. The chance that an adult over age 50 will have an osteoporosis-related fracture during the remainder of their life span is approximately one in two for women and one in four to five for men.[58]

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Etiology

Bone mass is gained primarily during growth periods, with peak bone density reached between age 18 and 30. Subsequently, bone mass remains stable until about age 40–50 for women (menopause) and about age 60 for men. Inadequate building of peak bone mass coupled with significant bone loss leads to low bone density.

Inadequate Bone Mass Although osteoporosis is seen most often in the elderly, the risk for developing osteoporosis in later years begins during childhood and adolescence. Development of osteoporosis is delayed when an individual develops bigger, denser bones during youth. For example, an epidemiological study in Yugoslavia showed that higher calcium intake in youth led to higher peak bone mass, independent of exercise and other factors. Higher bone mass is associated with slower decline in later life.[59] Studies in the United States have also shown that getting enough calcium during growth spurts (ages 11–17) reduces the risk of osteoporosis. In an intervention study, girls aged 11–12 years who received calcium supplements (500 mg calcium citrate-malate) gained an additional 1.3 percent bone mineral density per year compared to controls.[60]

Inactivity, including bed rest and a sedentary lifestyle, leads to loss of bone and muscle tissue. Bone mass develops in response to weight-bearing or resistance exercises because bone grows in response to pressure on the bone tissue. The more often and the harder you push on the bone (not enough to break it, of course), the more the body will respond by depositing minerals (calcium, magnesium, phosphorus, fluoride, and boron) into the bone matrix. For instance, tennis players have significantly higher bone mass in their playing arm than do nonathletic counterparts. Individuals have greater bone mass in their dominant arm than in the less-used one. Exercise also stimulates growth hormone, which in turn stimulates bone development. "Use it or lose it" applies here. Adults who are frail may fear falls and fractures so that it discourages them from getting much-needed exercise, contributing to a vicious circle.

Increased Bone Loss The skeleton acts as structural support and as a calcium reservoir for the body. Bone tissue includes jawbones and teeth. Bones and teeth contain about 99 percent of the calcium in an adult. The remaining 1 percent of calcium is found linked with protein in blood, soft tissues, and extracellular fluids. This reservoir is used for nerve transmission, muscle contraction, and enzyme systems such as those controlling blood clotting. Maintaining nerve transmissions takes physiologic priority over maintaining bone structure. In order for calcium to be consistently available, it is tightly regulated by hormone systems. Parathyroid hormone (PTH) levels are increased by low blood 25-hydroxy vitamin D levels, by high phosphate levels, and by low calcium levels. When calcium levels in the blood fall, the body responds by secreting more PTH. PTH acts to raise blood calcium levels by increasing dietary calcium absorption, decreasing urinary excretion, and by releasing calcium from bone. People with hypoparathyroidism take calcium supplements because there is not enough PTH to stimulate release of calcium from the bone reservoir in order to raise calcium levels to normal. The hormone calcitonin slows release of stored calcium. Calcitonin secretion is stimulated when blood calcium levels are high.

Bone mineral reserves are dissolved (resorption) and rebuilt continuously. A consistent dietary supply of bone-building minerals (i.e., calcium, magnesium, phosphorus, fluoride, boron, zinc, copper, and manganese) and vitamins (primarily D) coupled with regular weight-bearing exercise helps maintain the skeletal mineral reserves. When a portion of this build-dissolve-rebuild cycle is malfunctioning, the body's first priority is to maintain blood calcium levels for nerve, muscle, and enzyme functions.

Osteoporosis can develop from a shortage of phosphorus during bone mineralization. A varied diet provides a balanced calcium–phosphate ratio and allows both nutrients to be used by the osteoblasts (cells that build bone). Lack of sufficient phosphorus promotes release of calcium from the skeleton. Although phosphorus is abundant in the food supply, some antacids bind with phosphorus, making it unusable by the body and delaying bone formation until more phosphate is available. Shortage of vitamin D also delays bone mineralization.

Finally, the process of normal aging results in a slow increase of PTH as well as a decrease in the skin's ability to make vitamin D; both lead to bone loss.

Effects of Osteoporosis

Falls and Fractures Not everyone who falls sustains a fracture. However, deaths from unintentional injuries are the seventh-leading cause of death among older adults,[9] and falls account for the leading cause of those deaths. Approximately one in four U.S. residents aged ≥65 years report falling each year.[61] Fractures and the resulting injuries may make it impossible for an older adult to remain independent. Ten to 20 percent of older persons who break a hip die within a year.[62] Death is not due to the fracture itself but to complications resulting from the break. One of these complications is impaired mobility, complicating all the activities of daily living (including eating and exercising). If an older adult has also had a stroke, impaired mobility becomes the leading cause of institutionalization in the United States. Furthermore, 50 percent of older individuals who fracture a hip have permanent functional disabilities. Falls generate fear in older adults; these feared events are largely preventable.

Shrinking Height, Kyphosis In contrast to hip fractures, most vertebral fractures (67 percent) are asymptomatic. Postmenopausal women with compression and/or a bone fracture in the spinal column have a condition

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known as "shrinking height," leading to dowager's hump (also known as *kyphosis*, meaning a bent upper spine). Shrinking in height is slow and usually not painful. For example, a woman who was 5 ft 6 in. tall at age 30 may measure 5 ft tall at age 83. She may not notice the gradual height loss until someone comments or until she notices that clothes no longer fit. Compression of vertebrae can be a reason for increasing lumbar vertebrae bone mass in DXA scans, making wrist and hip scores better predictors of osteoporosis.

Risk Factors Osteoporosis tends to be most common among White women who are of lower weight. Brittle bones develop from a complex array of physiological factors, including poor nutrition and lack of exercise (Table 19.8). The WHO developed an online calculator that generates a 10-year probability of fracture based on several risk factors, such as age, height, weight, smoking, having had a previous fracture, and bone mass density score based on the type of DXA machine used.

Nutritional Remedies

Calcium On average, older Americans are consuming less calcium than the DRI of 1,200 mg per day (Table 18.11). The goal is to provide enough available calcium and vitamin D through diet or supplements so that bone loss is minimized despite declining absorption rates. Many foods are good sources of calcium, and a sample meal plan that provides the DRI for calcium is shown in Table 19.9.

Adhering to a calcium supplementation routine may not be any easier than eating a healthful diet every day. In a 5-year, double-blind, placebo-controlled study with nearly 1,500 women, mean age 75 years, the authors concluded that supplementation with 1,200 mg of calcium carbonate per day "is effective in those patients who are compliant."[63] The problem in recommending calcium supplementation to prevent clinical fractures was "poor long-term compliance."

Table 19.8 Risk factors associated with osteoporosis in older adults

Not Modifiable
Female, multiple pregnancies, intervals between pregnancies
Age at which pregnancy(ies) occurred, breastfeeding
Family history of osteoporosis, maternal history of hip fracture
White, Asian
Thin, small-boned rather than large-boned
History of amenorrhea, premature menopause
Hypogonadism, low levels of testosterone
Extensive steroid use
Potentially Modifiable
Muscle wasting, sarcopenia
Cigarette smoking
Long-term dietary phosphorus deficiency (e.g., use of phosphorus-binding antacid)
Heavy alcohol consumption
Malnourished
Inadequate dietary calcium, vitamin D intake

Table 19.9 An example of 1 day's food that provides at least 1,200 mg calcium

Food	Amount of Calcium (mg)
Oatmeal made with milk 1 cup total	266
Banana, one medium	6
Coffee, 10 oz with 1 oz (2 Tbsp) evaporated milk	87
Turkey sandwich on whole-wheat bread, lettuce, mayonnaise	54
Cheese added to sandwich, 1 oz cheddar	148
Apple	2
Iced tea, plain	0
Orange juice, calcium-fortified, 8 oz	289
Roasted almonds, 2 Tbsp	33
Pasta with chicken, 1½ cup	54
Lettuce and tomato salad	26
Sugar cookie, 1 medium	5
Chocolate milk, 8 oz	287

Vitamin D Adults aged 50 years and older should aim for 600–800 IU per day. Vitamin D stimulates active calcium transport in the small intestine and colon. Sources of vitamin D are sunlight, food, and supplements. The time of day, season, latitude, skin pigmentation, and age all determine the amount of vitamin D that the skin can generate. It is difficult to obtain the vitamin from food alone, so individuals with seasonally ineffective sun exposure may require supplemental vitamin D to maintain blood levels to suppress PTH and increase calcium absorption.

Balancing Nutrients for Bone Health While calcium and vitamin D are the best-known nutrients when it comes to bone health, other dietary components contribute to the complex relationships among hormones, muscles, and bones. The relationship between protein intake and bone health has been controversial. Studies showed that high protein intake may lead to an increase in bone fracture risk.[64] However, the International Osteoporosis Foundation (IOF) issued an expert consensus paper on the benefits and safety of dietary protein for bone health and concluded that protein intake in amounts even higher than the RDA is associated with higher bone mineral density, a slower rate of bone loss, and reduced risk of hip fracture when calcium intake is adequate."[65] In fact, insufficient dietary protein intakes may be a more severe problem than protein excess in older adults.

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To promote the effective daily remodeling of bone, several nutritional habits can improve calcium intake and absorption:

- Consume calcium-rich beverages like milk and kefir or yogurt drinks with a meal: food slows intestinal transit time and allows more calcium to be absorbed from the gut; protein from dairy products becomes substrate for new bone matrix.
- Increase fruit and vegetable intake for their alkalinizing effect; the alkaline environment improves calcium balance by inhibiting bone resorption.[66,67]
- Consume foods that are rich in bone-building vitamins and minerals at recommended levels. This balance will promote bone synthesis of the collagen matrix, into which minerals are deposited during bone mineralization.
- High sodium intake leads to higher levels of urinary calcium.
- Caffeine to equal 2–3 cups of coffee daily (in postmenopausal women), consumed in conjunction with a low calcium intake, has been associated with bone loss.
- If taking supplements, divide dosage throughout the day for greater absorption. Carbonate is better absorbed with food, while citrate is well absorbed with or without food. Take calcium at a different time than antacids, because stomach acidity enhances absorption. In cases where stomach acidity is decreased, calcium citrate is more soluble than calcium carbonate.

Exercise Weight-bearing exercise builds bones and muscle, which work in tandem to enhance balance and prevent falls. Bed rest and immobilization lead to rapid loss of bone mass; patients who are institutionalized will not stay strong without concerted effort.

Other Issues Affecting Nutritional Remedies

Hormones Hormones direct the dynamic system of bone remodeling. Estrogen, testosterone, growth hormone, and insulin-like growth factor-1 (IGF-1) increase intestinal calcium absorption. Hormone replacement, with or without additional calcium, can effectively increase bone mineral density in postmenopausal women. However, in 2002, the Women's Health Initiative reported increased rates of breast cancer, coronary heart disease, stroke, and venous thromboembolism in addition to decreased rates of hip fracture and colorectal disease from estrogen replacement.[68]

Medications Serotonin reuptake inhibitors (SSRIs) such as Prozac are frequently prescribed for depression; they are associated with bone loss. Serotonin produced in the duodenum suppresses osteoblast proliferation. There are intricate links between the skeleton, gut, and brain.[69] It seems easy to accept that blood cells and taste buds are renewed in a matter of days, but it is not so easy to picture bones as a dynamic tissue that is being remodeled continuously, even in old age. The remodeling systems of older adults are just not quite as efficient and resilient as those of younger adults.

In summary, the best osteoporosis prevention strategy is an adequate diet and exercise in young people when bones are first growing. For older individuals who have brittle bones, a nutrient-dense diet, potentially supplemented with calcium and vitamin D, coupled with appropriate exercise, strengthens bones. Bone-building medications require a physician's care.

19.8 Oral Health

It is possible to be well nourished without a full set of teeth, or even without any teeth at all (edentulous). However, the ability to bite and chew facilitates fruit and vegetable intake, which is linked to better health. Fortunately, more people are keeping their teeth as a result of better dental care. At the turn of the century, about one-third of all adults had no natural teeth; now that number has dropped to less than one-fourth of older adults who have no natural teeth. Edentulousness differs by race (Table 19.10) and is twice as likely among those who are at or below the poverty line.[70] Chewing is more effective with natural teeth; individuals who wear complete dentures have approximately 20 percent of the chewing ability of those having all natural teeth. Foods can be cut, sliced, chopped, grated, and made into smoothies and soups to ensure a varied diet when chewing ability is impaired. Lack of natural teeth does not have to result in a poor diet; however, this requires more effort. Nutrition education may be essential to assist in planning healthy diets. Studies have shown associations between edentulousness and inadequate intake of certain vitamins and minerals.[71,72]

Changes in oral health are most likely to be a result of disease, medical treatment, or medications rather than

Table 19.10 Proportion of older people who reported having no natural teeth, by age and race

Age and Race[a]	No Natural Teeth in 2011–2014 (%)
Age 65–74	13.9
Age 75 and older	23.0
Non-Hispanic White	16.2
Non-Hispanic Black	27.0
Non-Hispanic Asian	18.0
Hispanic	16.4

[a] Source: CDC/NCHS, CDC/NCHS, National Health and Nutrition Examination Survey, 2011–2012, Data Brief No. 197, May 2015. Available at https://www.cdc.gov/mmwr/volumes/66/wr/mm6603a12.htm, accessed March 13, 2018.

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aging itself. **Xerostomia** (known as dry mouth) and periodontal disease (PD) are two conditions that can interfere with food tolerance and with enjoyment of food. Xerostomia is a symptom of Sjögren syndrome. However, medications and other treatments are the most likely causes of dry mouth in the older population. For example, diuretic treatment for hypertension leads to decreased salivary secretion; other medications associated with dry mouth include antianxiety drugs, antidepressants, sedatives, and antihistamines. Head and neck cancer treatment can also lead to xerostomia when the salivary glands are involved. Lack of saliva for any reason gives bacteria a better environment to build plaque and damage teeth. Saliva helps to recoat the teeth with minerals and slow down infections. Xerostomia is often accompanied by loss of taste (dysgeusia) and pain of the tongue (glossodynia), factors that further interfere with the enjoyment of food.

The key treatment of xerostomia is good oral hygiene, especially after meals, plus stimulating saliva with sugar-free candy, frozen fruit bits, chewing sugar-free gums (xylitol, maltitol), and frequent sips of water. Artificial saliva and specialized mouth washes can also help keep the oral cavity moist.

PD results from bacterial infections of the **gingiva**, leading to destruction of the ligaments attaching teeth to the jawbone and to receding gums. Plaque builds up in the resultant pockets, contributing to further infection and eventual tooth loss. Over the years 2009 to 2014, 59.8 percent of U.S. adults ages 65–79 years had periodontitis.[73] PD increases with age, is higher in men than women and highest in underserved populations and smokers. People whose overall health and immune system are compromised are at greater risk for periodontal disease. PD is associated with atherosclerotic vascular disease (ASVD), although treatment that reduces PD and systemic inflammation has not yet been shown to prevent ASVD. PD has also been associated with diabetes although the specific mechanism has not been elucidated.[74] Prevention of PD emphasizes strict oral hygiene to remove plaque, enhance immune status, and ensure optimal nutrition. Evidence from an observational study using NHANES data found that DHA and EPA intakes at modest levels were associated with lower prevalence of PD in adults.[75] A systematic review showed that dietary but not supplemental omega-3 fatty acids was associated with lower PD severity.[76] It is hypothesized that omega-3 fatty acids may reduce chronic inflammation and hence reduce the symptoms of periodonditis. However, more research is needed before recommending these omega-3 fatty acids for oral health. Besides deficiencies of vitamin C and zinc that are associated with PD, correcting potential deficiencies of calcium, vitamin D, and magnesium will help postmenopausal women keep their bones, including the jaw, strong. Ensuring optimal nutrition includes management of diabetes. High blood sugar raises glucose in saliva, leading to caries and accelerated periodontal disease. It can also make the mouth more susceptible to yeast infection (candidiasis). Diabetes control translates into better oral health.

Good oral health for older adults also includes caries prevention. Brushing, flossing, and dietary recommendations for older adults match those of younger ones.

xerostomia Dry mouth can be a side effect of medications (especially antidepressants), of head and neck cancer treatments, of diabetes, and also a symptom of Sjögren's syndrome, which is an autoimmune disorder for which no cure is known.

gingiva Gum tissue.

19.9 Gastrointestinal Diseases

The gastrointestinal (GI) system serves so many functions that it should not be surprising to learn that by late adulthood, it occasionally malfunctions. It seems miraculous that we so consistently eat what we like, without much thought, and our body converts that food to energy for daily living. Parts of the GI system most likely to malfunction in old age are:

1. The esophageal-stomach juncture: weakened muscle results in *gastroesophageal reflux disease* (GERD)
2. The stomach: decreased acidity leading to *changes in nutrient absorption*
3. The intestines: *altered motility* resulting in constipation, diarrhea, and some specific food intolerances

Often these problems are secondary to other diseases. No matter what the cause, older adults are at higher risk for the GI conditions discussed next, any of which might impair older adults' activities.

Gastroesophageal Reflux Disease (GERD)

Definition GERD is a chronic disorder that results when stomach contents flow back into the esophagus, causing troublesome symptoms and/or complications. Clinical diagnosis is made based on symptoms of heartburn and regurgitation, supported by symptom response medication.[77] Contrary to earlier theories that GERD was part of a spectrum of diseases, it is now considered to be a set of discrete syndromes, with nonerosive reflux disease being the most common.

Prevalence Not all individuals with GERD symptoms seek medical care, so prevalence estimations can range widely. Gastroesophageal reflux disease is the most common GI-related diagnosis given in clinic visits. Prevalence statistics range from 10 to 20 percent of Americans experiencing at least weekly symptoms of heartburn to up to 40 percent of the U.S. population being affected with GERD.[78]

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Etiology and Effects It is not clear whether acid in the esophagus leads to a weakened **lower esophageal sphincter (LES)** or whether a weakened sphincter leads to GERD. The main symptoms of GERD are heartburn and acid regurgitation. Stomach contents, which are highly acidic, spill back into the esophagus, resulting in irritation, belching, hoarseness, and substernal pain. Ulceration and swallowing disorders are symptoms of severe cases of GERD. *Helicobacter pylori (H. pylori)*, a cause of peptic ulcer disease, does not cause GERD.[78,79] A review of the impact of gut microbiota on human health suggests that in old age, the symbiotic bacterial mix of the gut changes due to medication usage (e.g., antibiotics), resulting in decreased anti-inflammatory protection from *H. pylori* strains.[80]

Nutritional Risk Factors Excess alcohol, obesity, and smoking are consistently linked to GERD episodes. In addition, both regular and decaffeinated coffee are associated with heartburn.

Nutritional Remedies The main dietary remedy is to omit foods that are chemically or mechanically irritating. Variation in symptoms among individuals has contributed to making the diagnosis of GERD reliant on a patient-centered approach rather than on straightforward lab values or measurements. However, general guidelines are to choose a low-fat diet, avoid large meals, and to take advantage of gravity by remaining upright for several hours after eating. High-fat meals and alcohol both lower LES pressure. Fermented beverages (wine, beer) and caffeine stimulate gastric acid, so reducing them may give some relief. Protein also stimulates gastric acid, so consuming the necessary protein throughout the day rather than in one or two sittings will help to minimize reflux. Spicy foods, caffeine, chocolate, peppermint, citrus, and tomato products are among potentially reflux-pain-inducing foods.

Stomach Conditions Affect Nutrient Availability: Vitamin B_{12} Malabsorption

Definition and Etiology Absorption of vitamin B_{12} from foods requires stomach acidity, enzymes (especially pepsin), and intrinsic factor (IF). Stomach acids and enzymes split off and transfer vitamin B_{12} from foods to carrier proteins (mostly secreted by the salivary gland in the mouth). Then the vitamin B_{12}–carrier protein complex moves into the small intestine, where the vitamin B_{12} will again be broken off and bound to the IF (produced in the stomach and migrated to the small intestine). The vitamin B_{12}–IF linked complex then binds to a specific site in the lining of the small intestine, is transported across it, and released into blood serum to be taken to tissue cells (Figure 19.3).

Pernicious anemia and atrophic gastritis are two conditions that result in vitamin B_{12} deficiency. Pernicious anemia (macrocytic megaloblastic anemia), which is due to lack of IF being released from the stomach cell wall, is rare in individuals under 35. It is also uncommon even in older adults. The most common cause of vitamin B_{12} deficiency in older adults is related to abnormal stomach function. Prolonged inflammation, followed by the atrophied stomach mucosa secreting less acid, leads to atrophic gastritis. Older adults with atrophic gastritis still absorb some dietary vitamin B_{12}, but they will become deficient over time. Finally, antacid treatment neutralizes stomach acid and raises stomach pH, preventing vitamin B_{12} from being split from its protein carrier, even though the intrinsic vitamin B_{12} factor is present. Symptoms of vitamin B_{12} deficiency begin to appear after 3–6 years of poor absorption.

Prevalence and Detection **Cobalamin** (vitamin B_{12}) deficiency may be an underrecognized problem in older adults because the criteria used to assess B_{12} status is not consistent. Estimations of deficiency range from under 1 to 46 percent of the population, depending on the criteria used for diagnosis.[80] In a national study among a representative sample of the U.S. population, the prevalence of low-serum vitamin B_{12} ranged from 3 to 26 percent depending on the cut-off levels used.[81] Low-serum vitamin B_{12} was higher in women than men and depending on the criteria used, tended to be higher for adults aged 60 and over and in non-Hispanic Whites. In the United States, intake of vitamin B_{12} is more than adequate (Table 18.11), so low blood levels need to be evaluated in relation to other conditions such as atrophic gastritis, anemia, osteoporosis, and CVD.

Vitamin B_{12} status is dependent on two other nutrients: vitamin B_6 and folic acid. Blood levels of the coenzyme **homocysteine** could reflect a deficiency of dietary intake in one of any of the three nutrients. In contrast, another intermediate product, **methylmalonic acid (MMA)**, is only found

lower esophageal sphincter (LES) The muscle enabling closure of the junction between the esophagus and stomach.

cobalamin Another name for vitamin B_{12}. Important roles of cobalamin are fatty-acid metabolism, synthesis of nucleic acid (i.e., DNA, a complex protein that controls the formation of healthy new cells), and formation of the myelin sheath that protects nerve cells.

homocysteine Another intermediate product that depends on vitamin B_{12} for complete metabolism. However, both vitamin B_{12} and folate (another B vitamin) are coenzymes in the breakdown of certain protein components in this pathway. Thus, elevated homocysteine levels can result from vitamin B_{12}, folate, or pyridoxine deficiencies.

methylmalonic acid (MMA) An intermediate product that needs vitamin B_{12} as a coenzyme to complete the metabolic pathway for fatty-acid metabolism. Vitamin B_{12} is the only coenzyme in this reaction; when it is absent, the blood concentration of MMA rises.

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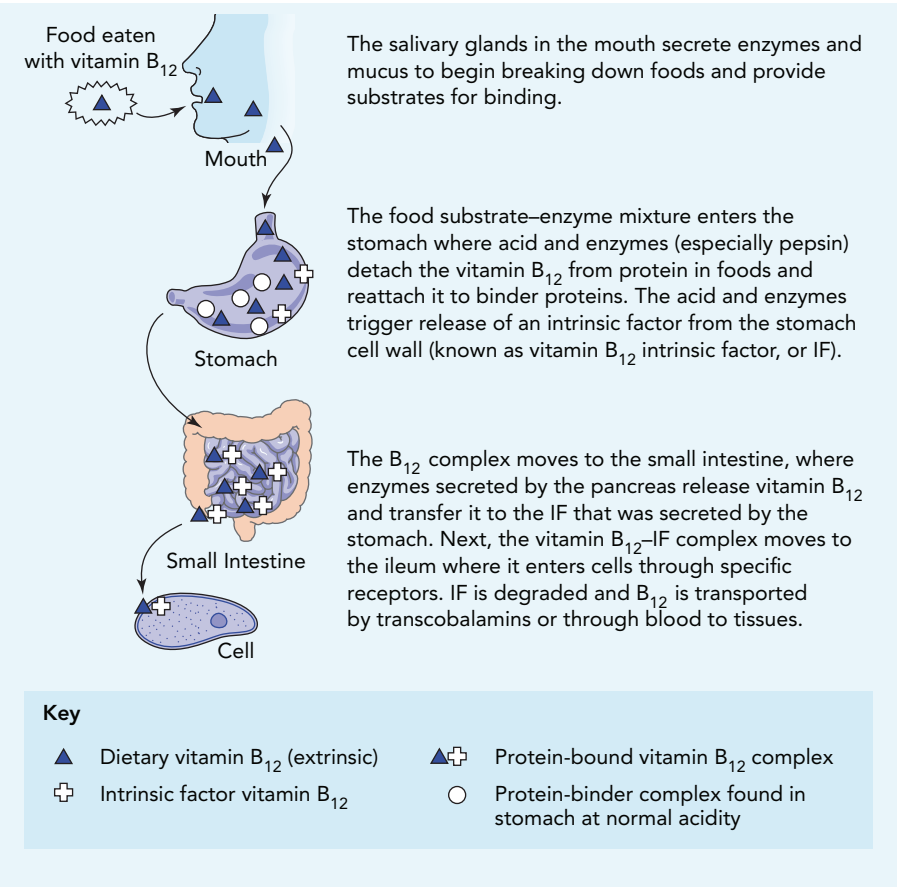


Figure 19.3 Overview of vitamin B_{12} absorption.

in a vitamin B_{12}–specific pathway. Therefore, rising blood levels of MMA occur when adequate amounts of vitamin B_{12} are unavailable. Elevated MMA and homocysteine levels confirm a vitamin B_{12} deficiency, whereas normal MMA together with elevated homocysteine levels indicates that folic acid deficiency or another cause should be investigated.

Effects Vitamin B_{12} is needed to make blood cells, DNA, and for normal brain function. Deficiency of the vitamin leads to anemia and potentially to irreversible neurological damage, walking and balance disturbances, and cognitive impairment (including confusion and mood changes). High levels of homocysteine are known to be a risk factor for heart and peripheral vascular disease. If a diet consists of high folic acid but is deficient in vitamin B_{12} anemia may be prevented but not cognitive dysfunction, and the impact of vitamin B_{12} deficiency on neurologic damage can proceed undetected.

Risk Factors Risk factors for vitamin B_{12} malabsorption include GI disorders, genetic family patterns, medications, and (to some extent) inadequate food intake particularly among strict vegetarians and vegans. GI disorders that affect vitamin B_{12} absorption include atrophic gastritis, which increases with age, partial stomach removal, and *H. pylori* infection. Medications that suppress stomach acid secretion or impair absorption are associated with the risk of deficiency. Examples of these types of medicines are oral biguanides (e.g., metformin used to treat type 2 diabetes mellitus), modified-release potassium preparations, hydrogen-receptor antagonists (e.g., Cimetidine® or Tagamet®), and proton pump inhibitors (e.g., omeprazole/Prilosec® given for gastroesophageal reflux disease).

Nutritional Remedies The DRI of vitamin B_{12} for adults of all ages is 2.4 mcg per day, and the tolerable upper intake level has not been determined. However, oral pharmacological doses for vitamin B_{12}–deficient patients are 0.2–2 mg (200–2,000 mcg) per day and are above the DRI because roughly 1–2 percent is absorbed through passive diffusion in the small intestine.[82] A dose-finding study tested vitamin B_{12} doses from 2.5 mcg to 1,000 mcg with healthy, free-living adults over age 70 and found that mild deficiencies can be normalized with doses of 500–1,000 mcg of cyanocobalamin, depending on the blood indicator measured.[83] Although the primary food source of vitamin B_{12} is from animal proteins, the bioavailability of the protein-bound vitamin decreases with age due to the decrease in stomach acidity. It is recommended that adults aged 51 and over obtain their vitamin B_{12} from foods fortified with crystalline or synthetic vitamin B_{12} or from supplements containing vitamin B_{12} because they are not bound to protein and, therefore, are not dependent on

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acidity for absorption. Folate is now abundant in the food supply due to fortification and so it is essential to ensure that vitamin B_{12} intake is adequate.

Constipation

Definition There are many definitions of "normal bowel pattern." Normal patterns of defecation can consist of two or three bowel movements per day to two or three bowel movements per week. To help sort out what constitutes an abnormal pattern, we turn to the Rome Foundation, which updates the criteria every 5 years for diagnosing functional GI disorders, now known as the disorders of gut-brain interaction (DGBI).[84] According to the Rome IV criteria, functional constipation in adults means that onset of symptoms occurred at least 6 months prior to diagnosis. For such a diagnosis, an individual had two or more of the following symptoms for at least 3 months (in 25 percent or more of defecations): straining, lumpy or hard stools, sensation of incomplete evacuation, sensation of blockage in rectum, manual manipulation to facilitate defecations, and fewer than three defecations per week.

Prevalence Constipation is quite prevalent, and depending on its definition can affect around 12–19 percent of the general population. Its prevalence increases with age and is more frequently reported in female patients; it affects 26 percent of women and 16 percent of men age 65 and over, and this increases to 34 and 26 percent of women and men, respectively, age 84 and over.[85] These rates are much lower than the percentage of the older population concerned about the regularity of their bowel movements.

Etiology and Effects Medications and diseases such as diabetes, cancer, Parkinson's, and irritable bowel and other gastric diseases are associated with constipation. There is also a public perception that "being regular" means having a bowel movement each morning. Enthusiastic publicity for celebrities' cleansing diets further contributes to perceptions that stool should be cleared from the colon daily. Older adults are not immune to these promotions. Writing about the widely held myths and misconceptions surrounding normal bowel movements, Müller–Lissner and three international gastroenterologist colleagues introduced their paper with an observation that could fit other conditions: "As with any widespread disorder that has been incompletely understood, there are many strongly held beliefs, which are often not evidence-based. . . ."[86] Staller and Cash in 2020 added to these myths and misperceptions with a focus on diagnosis and treatment[87] (Table 19.11). Stool transit times, weights, and consistencies vary greatly among healthy adults of all ages. This is understandable when considering the main functions of the colon, which are water conservation, serving as a place where bacterial action can digest food remnants to usable nutrients, and acting as a site for waste storage until suitable times and places for a bowel movement. Lower levels of stomach secretions and potentially less muscle strength affect peristalsis. Animal studies indicate that aging intestinal muscles become less responsive and that the brain–muscle transmitters are either faulty or less responsive. Also, older adults' thirst mechanisms become blunted and reduced fluid intake may lead to constipation. There is a potential for avoiding fiber-rich foods due to chewing problems; such low-fiber diets can also exacerbate **diverticulitis**. Declining cognitive function may become so severe that the individual may not recognize the urge to defecate; this can also lead to constipation or fecal incontinence.

Risk Factors Consistent evidence that exercise relieves constipation in older adults is lacking, although epidemiologic studies have found that higher levels of regular physical activity were associated with a lower risk for constipation.[88] Nutritional risk factors for constipation include:

- Dehydration
- Medications, such as opioid and nonsteroidal anti-inflammatory drugs
- Calcium and other mineral supplements and antacids
- Diets low in fiber

Nutritional Remedies Traditional remedies are to encourage increased dietary fiber in tandem with increased fluid. Fiber, fluid, and muscle tone together promote bowel movements; one needs all three.[89] In the presence of dehydration, adding fluid improves constipation. There are no studies available to suggest the minimum fluid intake that will maintain the normal bowel routine of an older adult. In healthy adults, fluid intake can vary widely while maintaining regular bowel movements.[87] Optimizing food and fiber intake will help create stool mass; on average, older adults fall far short of the recommended fiber intake. Insoluble fiber sources include bran and cellulose in fruits and vegetables; these fibers are fermented by the colonic bacteria, producing gas (leading to flatulence). Bacterial type and food residue determine gas production. Sugar alcohols are fermented in the colon, as are stachyose and raffinose, two of the carbohydrates in legumes. Bran in breads and cereals is one way to add to fecal bulk that stimulates peristalsis to move wastes through the colon. The fiber section of Chapter 18 offers suggestions for incorporating dietary fiber (Tables 18.12 and 18.13). Long-term care nutrition services have devised special recipes to wean residents off laxatives, such as incorporating psyllium fiber, applesauce, and juice into fruit-flavored gelatin. One old, but still particularly popular, method is called Behm's Special Recipe, or Power Pudding (Figure 19.4).[90] There is one caution before increasing fiber: Determine if there is

diverticulitis Infected "pockets" within the large intestine.

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Table 19.11 Misconceptions about chronic constipation

Common Myth	What the Evidence Shows
Stool that remains in the colon for a long time causes "autointoxication"; this theory gave rise to colonic cleansing, enemas.	There is no evidence that toxins are absorbed from the colon.
Bowel movement frequency is most important criteria for establishing diagnosis.	Not necessarily so as bowel movements vary from 3/day to 3/week.
An elongated colon may cause constipation because too much water is reabsorbed from stool, making it hard, and there is danger of kinking.	Calculated normal colon lengths in human adults ranged from about 95 to 180 cm in six studies reported; length depends on methodology. No studies link colonic length with transit time.
Hormones lead to constipation.	Some do; in a very small percentage of older adults, hypothyroidism is associated with constipation and hyperthyroidism with diarrhea.
Constipation is due to a diet low in fiber and is best treated with dietary fiber.	Fiber has various functions and is not digested uniformly; this complicates studies. Yes, fiber increases stool bulk. Wheat bran and psyllium reduce transit time. A low-fiber diet may be a contributor to constipation, but some cases of severe constipation are exacerbated by additional dietary fiber.
All fiber is created equal.	Fiber can have different characteristics. Nonfermentable, soluble fiber is the most appropriate initial choice.
Low fluid intake causes hard stool.	Interviews with older adults showed no association between estimated fluid intake and constipation; drinking mineral water may have a slight laxative effect due to magnesium content. Except in cases of dehydration, "available data do not suggest that stools can be manipulated to a clinically relevant extent by modifying fluid ingestion."
A sedentary lifestyle and inactivity lead to constipation.	Bowel-management programs in nursing homes (fiber, fluid, exercise) have reduced laxative consumption. "Intervention programs to increase physical activity as part of a broad rehabilitation program may help."
Laxative intake causes electrolyte disturbances and abdominal complaints.	Abdominal complaints occur with constipation and with laxative use; stimulant laxatives (senna, bisacodyl) may cause cramping; bulk-forming or osmotic agents may increase pressure that feels like bloating. Laxatives can cause electrolyte disturbances, but these can be managed.
Laxative use induces habituation and tolerance.	Limited studies of laxative tolerance suggest that tolerance is uncommon "in the majority of users." Those with severe cases using stimulant laxatives may need increasingly large doses.

Source: Table content compiled from summary information in References 87, 88.

Power Pudding, also known as Behm's Special Recipe[92]
1 cup applesauce
1 cup unprocessed bran, all-bran, or bran buds
½ cup prune juice

Mix all ingredients and refrigerate or freeze.
Serve 2 tablespoons at supper, follow by extra fluid such as 1 cup of water.

You can even find Power Pudding online:
1½ cups pitted prunes
1 cup unsweetened applesauce
½ cup All-Bran
¾ cup prune juice
Put all ingredients into blender and puree until smooth.
Serve ¼ cup daily, followed by a glass of water.

Figure 19.4 High-fiber recipes as alternative to laxatives.

gluten A protein found in wheat, spelt, kamut, dinkel, and triticale (genus Triticum), barley, and rye. Spelt, dinkel, and kamut are ancestral forms of today's wheat. Oats appear on some "gluten" lists; oats are inherently gluten free, but they may be contaminated by gluten-containing grains during processing.

potential for fecal impaction due to disease such as colon cancer. Integrating activity and exercise training can improve peristalsis and alleviate constipation; it may also relieve bloating and flatulence.

19.10 Inflammatory Diseases: Osteoarthritis

Inflammatory diseases include periodontal disease, osteoarthritis, rheumatoid arthritis, celiac disease (**gluten** intolerance), irritable bowel disease, diverticulitis (an infection in the large intestine), atrophic gastritis, and asthma. Of these conditions, arthritis affects the greatest number of older individuals.

Osteoarthritis (OA) is the focus of this section because it is the most common form of arthritis. During 2016–2018, more than half (50.4 percent) of a representative sample of adults aged 65 and over had doctor-diagnosed arthritis. In that survey, the prevalence of arthritis increased with increasing age, body mass index (BMI), physical inactivity, and worsening psychological distress and self-rated health, and decreased with increasing educational attainment and

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income-to-poverty ratio.[90] Incidence increases with age, but levels off around age 75–80. OA is among the leading causes of disability in community-dwelling adults; of patients with OA, 80 percent have some limitations of movement. Women are at higher risk of OA than men (Case Study 19.1).

Etiology

OA has no known cause, although genetic triggers have been linked to its development. It is characterized by degeneration of bone and cartilage in joints, bone hypertrophy, changes in the synovial membrane, hardening of soft tissues, and inflammation, leading to tissue damage. Variability in occurrence and progression of knee, hip, and hand OA suggests that the disease may be a group of different and unique conditions. In contrast to OA, rheumatoid arthritis is an autoimmune collagen disease, also characterized by inflammation.

Effects of Osteoarthritis

OA inflammation causes pain, stiffness, and swelling. Currently, there is no cure. OA is among the most disabling conditions of older adults. Although functional decline does not have to affect nutritional status, it is likely to complicate one or more of the steps needed to eat well: food procurement, safe preparation, cleanup, and simple enjoyment. Pain colors activities of everyday living, leaving individuals exhausted and frustrated. Treatment goals are to control pain, improve joint function, maintain a normal body weight, and achieve a healthy lifestyle. Treatment can include a combination of physical therapy, weight control, use of medications, and eventually total joint replacement.

Risk Factors

Obesity, joint injuries, and muscle weakness are modifiable risk factors for developing OA. Possible risk factors include continuous overexposure to oxidants, and possibly low vitamin D levels. The relationship between vitamin D and progression of OA and/or pain reduction is inconclusive. In one study, individuals with low serum vitamin D had elevated risk of knee OA progression compared to those with higher vitamin D concentrations.[91] However, a clinical trial did not show reduced symptoms or progression of OA with vitamin D supplementation

Case Study 19.1 Bridget Doyle Remembers Laura

Just because she lives at Lenoir Manor, a continuing-care retirement facility, Laura, a petite (4 ft 8 in., 97 lb) widow of the local college dean, does not consider herself as old. She is 87. She has had no major nutritional or health problems and her appetite is good. She had been a good cook and entertained graciously, but in the residential care facility, meals are prepared for her. Because she has had slight fluid retention over the past year, she no longer adds salt to her meals. She tells Bridget Doyle, her nutritionist, that yes, occasionally she does not like her meals and misses cooking for herself.

One Monday morning, Laura is found in bed with her left side paralyzed. The diagnosis is a right-sided stroke, resulting in 3 weeks of hospitalization. Back at the skilled-care wing of Lenoir, Laura needs a nasogastric tube for feeding. She is alert and knows people but is limited in speech. Overnight, Laura's care has changed from an individual needing routine nutritional monitoring to someone with many interrelated problems:

- Inability to communicate her overall medical and nutritional concerns clearly
- Weight loss of 9 lb during the 3-week hospital stay
- Intense dislike of the nasal tube, as demonstrated by repeated attempts to pull it out, leading to restraint of her hands

Questions

Assessment

1. What nutritional parameters should be assessed and monitored now that Laura is back at Lenoir Manor?

Diagnosis

2. What disciplines should be involved in Laura's care plan, and why?
3. The interdisciplinary care team wants to meet Laura's needs in a dignified and respectful manner. How can the care team address both clinical and ethical concerns?
4. What are strategies young adults can adopt to reduce their risk of stroke?

Monitoring and Evaluation

5. How could Bridget ensure that Laura's nutritional needs are met?



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over 2 years.[92] A systematic review and meta-analysis that examined the association between vitamin D and knee OA did not find an association between serum levels of vitamin D and the prevalence, incidence or progression of knee radiographic OA and joint space narrowing.[93] Osteoporosis has been inversely linked to OA. Obesity may have two detrimental effects. One is the weight stressing the joint, and the other is due to secretion of cytokines in adipose tissue. Fat, a metabolically active tissue, secretes signaling molecules that can trigger inflammation.

Nutritional Remedies A painful, incurable disease with high prevalence but with unknown causes is likely to generate great public interest and experimentation in its treatment. Treatments used in OA far exceed the evidence of effectiveness. Overall, weight loss and certain exercises have a positive impact on decreasing pain and improving physical function and health. Messier and associates[11] found that weight loss of as little as 1 lb reduces the load exerted on the knees. Herbal medicinal products are frequently used in the treatment of OA; however, at this time, there is insufficient evidence of the effectiveness of these products.[94] Other popular nutritional approaches to symptom reduction have small or no evidence of benefit. For example, anti-inflammatory diets have become popular. However, a healthy diet following the Dietary Guidelines, the DASH, or Mediterranean eating patterns is the recommended approach.[95]

Chondroitin and Glucosamine These two substances naturally occur in the body as substrate for cartilage repair. Clinical trials of their use, separately and together, demonstrate significant pain reduction when knee pain is moderate to severe.[96] Joint space in the knee improved and hip progression was slowed. However, a meta-analysis of studies of randomized placebo-controlled trials that investigated the efficacy of glucosamine and chondroitin sulfate on knee OA symptoms showed that each alone reduced pain in knee OA but there was no additional effect using both therapeutic agents together.[97] A caution: Product tests have shown that quality and levels of active compound display surprisingly great variation. Not all products contain the specified levels of active compound. Check with the Food and Drug Administration (FDA) or go to www.consumerlab.com to find out how specific brands rate.

memory impairment Moderate or severe impairment is when four or fewer words can be recalled from a list of 20.

mild cognitive impairment (MCI) Subtle loss of memory, thinking, and/or reasoning skills beyond expectations of normal but not serious enough to be classified as dementia.

Other Treatments There is no conclusive evidence currently to recommend vitamin intake to relieve OA symptoms or to prevent its progression. Balancing specific fatty acids and oils has potential to reduce inflammation, but there is no solid intervention data to show that it reduces symptoms of either osteo- or rheumatoid arthritis. Other treatments such as borage seed and evening primrose oils contain GLA or gamma-linolenic acid, which play a role in prostaglandin synthesis (GLA competes with other fatty acids, limiting the production of inflammatory omega-6 fatty acids) and are popular even though not proven in clinical studies. Flaxseed and purslane also contain a form of omega-3 fatty acid. Traditional Native American medical therapy used echinacea (three varieties) for pain relief, rheumatism, and arthritis; ginseng for asthma and rheumatism; garlic for asthma; and evening primrose oil for obesity.[98] There are not enough studies to assess the efficacy of many of these treatments. Disease treatment claims can't be made on the container unless they are backed by evidence, but dietary supplements typically don't undergo drug testing. Marketing for the botanicals used by many older adults is often driven by tradition and personal testimonials (blogs, articles, books, websites). Echinacea and ginseng are said to boost immune function, and evening primrose oil serves as an antioxidant—customers often leap to the assumption that these will treat inflammatory diseases such as OA.

19.11 Cognitive Impairment, Dementia, and Alzheimer's Disease

Definition

One of the dreaded aspects of "getting old" is becoming dependent on others. **Memory impairment** and **mild cognitive impairment (MCI)** are steps in the loss of independence. Serious losses of memory and cognitive function are frequently grouped under the term *dementia*. Dementia is a condition of progressive cognitive decline, typically characterized by impaired memory, thinking, decision making, and linguistic ability. Dementia is not a disease itself, but rather the manifestation of various forms of physiological damage. Diseases associated with dementia include Alzheimer's disease (AD), Parkinson's disease, alcoholism, and vascular diseases (Table 19.12).

AD is the most common cause of dementia and accounts for an estimated 60–80 percent of cases.[99] Revised diagnostic criteria published in 2011[100] defined dementia as the last of three stages in the AD progression and created separate diagnostic recommendations for the preclinical, mild cognitive impairment and dementia stages of AD. Dementia may, but does not necessarily, follow a

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Table 19.12 Conditions associated with cognitive impairment and dementia

Condition	Changes Leading to Cognitive Impairment
Vascular dementia	"Mini-strokes" and vascular obstructions deprive brain of oxygen and other nutrients.
Degenerative diseases (Alzheimer's and Parkinson's)	Neurological changes eventually affect memory and the ability to think.
Physical trauma and infection	Brain injuries may impair physical and/or cognitive function.
Depression	Change in brain chemistry can affect the ability to maintain high-level functioning.
Chronic substance, alcohol abuse	Neurological damage may become irreversible.
Malnutrition, including vitamin B_{12} deficiency and dehydration	Confusion resulting from dehydration is reversible. Neurological damage of vitamin B_{12} deficiency is permanent. Chronic hunger keeps the brain from focusing on life beyond acquiring food.
Deficiencies of niacin, thiamin, folic acid, biotin, iron, and selenium	Decreased ability to learn and depression are among the effects of these vitamin and mineral deficiencies.

symptomatic, pre-dementia phase labeled MCI. MCI may include reduced ability to learn and retain new information, but it does not interfere significantly with day-to-day activities or the ability to live independently. Cognitive decline results from accumulation of beta-amyloid plaques and synaptic dysfunction, formation of neurofibrillary tau protein tangles, and neuronal death.[101] In a unifying update, the National Institute on Aging and the Alzheimer Association developed a framework which shift the definition of AD from syndromal to a biological construct and focuses on AD as a continuum. The diagnosis of AD not only uses the biomarkers β amyloid deposition, pathologic tau, and neurodegeneration, but also maintains the staging of the severity of cognitive impairment.[101]

Prevalence

AD ranked fifth in leading causes of death for adults aged 65 and older in the United States in 2019. In 2022, about 11 percent of people age 65 and older and 33 percent age 85 and older have AD in the United States.[100] The number of people ages 65 and older with Alzheimer's dementia is projected to increase from 6.5 million Americans in 2022 to 12.7 million by 2050.[100]

Etiology of Cognitive Impairment

Dementia can be caused by a variety of conditions, resulting in traumatic physiologic changes (Table 19.12). The symptoms of dementia may be completely or partially reversible in some conditions, including reduction of cerebrovascular risk factors, early treatment of drug abuse, metabolic disorders such as a vitamin B_{12} deficiency and hypoglycemia, and medical interventions such as surgery to remove tumors or change of medications.

Nontreatable forms of dementia include those associated with degenerative diseases such as Alzheimer's, Huntington's, and Parkinson's. Searches for a cause of AD (leading to treatment) are ongoing. Aluminum, copper, carnitine, vitamin B_6, and choline have been examined as possible causes of AD due to their role in neurological function, but have not been demonstrated to be causal.

Deficiencies of vitamin B_{12} and folate are related to high concentrations of homocysteine, an amino acid associated with the promotion of poor vascular health and cognitive decline. In order to prevent the buildup of homocysteine in the blood and neural tissue, vitamin B_{12} and folate are needed to convert it to the amino acid methionine. Methionine contributes to the synthesis of *S*-adenosylmethionine, which is widely distributed throughout the central nervous system for use in methylation reactions. Primary examples of methylation reactions include vitamin B_{12} in the production of myelin (the insulation cover on nerves) and folate in the DNA cycle (cell replication). Excess homocysteine in brain tissue is thought to contribute to the development of AD either through vascular mechanisms or as a neurotoxin. High-dose vitamin B supplementation has decreased homocysteine levels but has not slowed progression of cognitive decline in people with AD.[102]

To discover dietary habits that may prevent cognitive decline, and especially AD, researchers are reviewing dietary patterns and physical activity. There is accumulating evidence that aerobic exercise and the Mediterranean diet have a positive impact on improving cognitive ability and prolonging longevity. A systematic review of studies up to May 2014 that examined the role of dietary patterns in relation to cognitive decline or dementia shows that better adherence to a Mediterranean diet is associated with less cognitive decline, dementia, or AD.[103] For example, researchers of a prospective cohort study in Bordeaux, France, developed an adherence score and assessed the dietary patterns of 1,410 adults aged 65 and older.[104] After adjustment for cardiovascular risk factors, higher adherence to the Mediterranean diet was associated with slowed cognitive decline in one of the four cognitive function tests (the Mini-Mental State Exam). Another systematic review that examined several dietary patterns and cognition found that the Mediterranean diet had a consistent protective effect against cognitive decline and although the evidence was more limited, there was a protective effect with other dietary patterns such as the MIND, DASH, Anti-inflammatory and Prudent diets.[105] Intervention studies with long follow-ups are needed to support these findings.

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Other promising research into the mechanisms of cognition in aging deals with the theory of caloric restriction and inflammation.[106] A small intervention study in humans (29 healthy women, mean age 60.5 years) showed that a reduced-calorie diet (30 percent below normal intake, not to drop below 1,200 kcal) improved insulin sensitivity, inflammatory response (tumor necrosis factor-alpha), and memory performance on the Rey Auditory Verbal Learning Task test. Both obesity and long-term underweight were associated with lower cognitive scores in the larger Whitehall Cohort Study.[107]

The term *cognitive disorders* describe a range of brain malfunctions. The etiology of AD may be elusive, but any progress into elucidating contributors to cognitive health will find an appreciative audience, both in individuals with the disorder and, perhaps more so, in their caregivers.

Effects of Cognitive Impairment

Confusion, anxiety, agitation, loss of oral muscular control, impairment of hunger and appetite regulation, changes in smell and taste, chewing and swallowing difficulties, and dental problems are all aspects of AD that make it difficult to maintain good nutritional habits. As the disease advances, individuals with AD will require more and more assistance with meal preparation and eating. In later stages of the disease, wandering and restless movements expend energy and increase caloric need. Behavioral, physical, or neurologic problems may impede adequate food intake. Consequently, individuals with late-stage AD suffer from unintentional weight loss (this is discussed in the "Low Body Weight/Unintentional Weight Loss" section).

Nutrition Interventions for Cognitive Impairment

After examination of 25 systematic reviews and 250 primary research studies, an independent panel concluded its 727-page report into the research of protective factors for AD, saying that evidence is inadequate "to confidently assess their [the factors'] association with AD or cognitive decline."[108] The panel did find that cognitive engagement and physical activities were associated with decreased risk of AD. However, this panel did not address the many different types of cognitive impairment (Table 19.12).

The search for hope includes food and medication. Researchers at a 2012 presentation at the International Alzheimer's Association Congress reported on a medical food supplement designed to support the formation and function of nerve synapses. Ingredients include fish oil components, antioxidants, and B vitamins; however, a double-blind trial showed no difference in cognitive functional outcome.[109] There are a few medications available; however, these drugs help manage symptoms of the disease but cannot cure it. In June 2021, the FDA approved a new drug to treat Alzheimer's disease, but it is controversial due to concerns over its safety, effectiveness, and cost.

In the meantime, ensuring food safety and safe use of kitchen tools and equipment are primary considerations for good nutrition; many dangers lurk in the kitchens of people who are cognitively impaired and trying to maintain an independent life at home. Involving a caretaker can ensure adequate intake while preventing foodborne illness or injuries related to food preparation.

Since there is no cure for AD, the dietary focus is to maintain a nutrient-dense diet that is acceptable to the individual, maintains hydration, and supplies needed energy. Additional calories may be needed for increased energy expended by individuals who pace and wander. People with dementia can benefit from meals offered in a calm dining environment, free of loud noise and confusion (no highly patterned tableware, nothing extraneous on the table). Additional strategies caregivers might use to promote food and fluid intake are to (1) maintain the focus on eating, (2) provide plenty of time to eat, (3) serve finger foods, and (4) encourage regular drinks between bites. In cases of decreased physical coordination, adaptive eating utensils, such as slip-resistant placemats, mugs or cups without saucers and spoons, and silverware with built-up handles, may promote independent eating.

19.12 Polypharmacy: Prescription and Over-the-Counter Medications

Prescription medicines are those ordered by a physician or other licensed health-care provider, and do not include vitamins, herbal medicines, or over-the-counter (OTC) medicines. OTC medications are any pills, liquids, salves, creams, and supplements that are purchased at a pharmacy, discount, or food store without prescription. Complementary medicines such as botanicals and herbs are typically sold as OTCs.

Several terms have been used to describe multiple medication usage. Polypharmacy and hyperpharmacotherapy refer to use of multiple and/or inappropriate medications. Use of multiple medications increases the risk of adverse drug reactions, hospitalization, and death.[110] Using three or more medications per day (prescription or OTC) constitutes nutritional risk on the Nutrition Screening Initiative DETERMINE tool (Figure 18.2). On the MNA long form (assessment, not screen), nutritional risk is defined as more than three prescription drugs per day.

How many drugs does the average older person take, assuming that there is an average old person? It is difficult, maybe impossible, to find a meaningful number; the emphasis of prescribers is on *appropriate* medications. The American Geriatrics Society 2015 Beers Criteria provide a list of medication to health care providers to help prescribe safer medications to older adults.[111] In 2015–2018, more than 40 percent of adults ages 65 and older used five

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or more prescription medications. From 1988–1994 to 2015–2018, there were substantial increases in medication use.[14] In 2015–2016, lipid-lowering drugs consisted of almost 50 percent (46.3 percent) of prescription drugs.[112]

Medication Effects on Physical, Mental, and Financial Status

The potential for medication errors increases with disease progression, drug side effects, functional limitations such as poor eyesight or impaired memory, and number of drugs used. Taking multiple medications is inevitable for an individual with multiple illnesses, and it can affect mental, physical, and financial security. Worry about tracking and taking drugs properly, perhaps while having undesired side effects like dry mouth, decreased taste sensation, and sleepiness, can lead to periodic "forgetting" to take a pill. Budget shortfalls can add to the worry: Shall I buy food for the cat, fresh fruit for me, or blood pressure medicine? In the absence of money or insurance coverage, older adults have been known to divide pills and take half doses.

Older patients taking multiple prescribed drugs tend to be more frail. In the Australian CHAMP study of nearly 3,000 free-living men aged 70 and older, the group taking 10 or more prescribed medications (compared to 5 or more) was older and experienced proportionately greater weight loss (19 percent of the group compared to 10 percent), weakness (56 percent compared to 43 percent), and low activity (51 percent compared to 32 percent).[111]

Medication Effects on Food Consumption

Medications may require dietary restrictions and can interfere with appetite, digestion, metabolism, and general alertness. For example, the blood-thinning drug warfarin requires a stable vitamin K intake (Table 19.13). Other medications alter the senses of taste and smell. Eliminating the pleasure of a meal is an obvious loss, but unforeseen circumstances include injuries from falls. For an example, take the case report of drug-related taste disturbance from two Canadian physicians. They describe the case of an 85-year-old fully functioning woman, admitted to the ER with fractures and intracranial hemorrhages after taking a misstep during her nightly trip to the bathroom.[113] She had started taking eye drops for glaucoma. These drops left her with a bitter taste, which she tried to wash away with a glass or two of water, resulting in nocturia, which is waking up at night to urinate. On that night, she tumbled down seven steps; she had mistaken the stairwell for the adjacent bathroom door, resulting in a trip to the emergency department. Bitter taste is likely to be listed as one of the side effects on the eye drop package insert, but the

Table 19.13 Amounts of vitamin K in selected fruits and vegetables (DRI for ages 51 and older is 120 mcg/day for men, 90 mcg/day for women)

Less than 5 mcg vitamin K:
1 cup servings of applesauce, cherries, corn, mushrooms, navy and baked beans, onions, pineapple, potatoes, strawberries
1 each of apple, banana, orange, nectarine, peach, pear, or tangerine; 5 dried apricots, 5 dates
5 to 10 mcg vitamin K:
1 cup canned apricots, chickpeas, lima beans, fruit cocktail, fresh raspberries, papaya, all varieties of squash, stewed tomatoes, sweet potatoes
10 and <50 mcg vitamin K:
1 cup blueberries, raw red cabbage, carrots, cauliflower, celery, cucumber with and without peel, iceberg lettuce, roasted peppers, canned plums, grapes, string beans
½ cup cooked chard, prunes or dried plums
1 kiwi, 2 sprigs parsley, 1 Tbsp raw green onion
50 mcg vitamin K (1 cup cooked unless specified):
Beet greens, turnip greens (529–851)
Broccoli (183–220)
Cabbage (27–58)
Collards (836–1,059)
Kale (1,062–1,147)
Mustard greens (419)
Okra (64)
Rhubarb (71)
Cooked spinach (1,027)
1 cup raw: green leaf lettuce (97), Romaine (57), spinach (145)

Source: Available at https://ndb.nal.usda.gov/ndb/nutrients/report?nutrient1=430&nutrient2=&nutrient3=&fg=&subset=0&offset=0&sort=c&totCount=4878&measureby=m hypertension, accessed April 1, 2018.

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Table 19.14 Medications associated with chronic conditions in older adults: Nutritional implications

Coronary Heart Disease

Cardiac glycosides (e.g., digitalis) may result in anorexia and/or nausea.

Statins may result in elevated liver enzymes.

High doses of niacin may be associated with flushing, hyperglycemia, hypotension, hypoalbuminemia, upper GI distress, and liver enzyme elevation.

Hypertension

Diuretics may result in depletion of sodium, calcium, magnesium, and/or potassium.

Centrally acting antihypertensives may result in a decline in food intake due to sedation, confusion, and depression.

Medications such as beta-blockers may cause constipation and delayed gastric emptying.

Potential related side effects are dizziness, dry mouth, or mouth pain.

Diabetes Mellitus

Medications to treat diabetes may cause hypoglycemia, especially if nutritional intake is erratic and/or if there is increased or decreased appetite or diarrhea.

Oral hypoglycemics (e.g., sulfonylureas such as glipizide) may cause heartburn, nausea, hypoglycemia, decreased appetite; biguanides (such as glucophage) may cause decreased appetite, diarrhea, and vomiting.

Depression

Antipsychotic/antidepressants with anticholinergic side effects may lead to dry mouth, delayed stomach emptying, and constipation.

Antidepressants may enhance appetite in depressed patients, but selective serotonin reuptake inhibitors may cause a decrease in appetite.

Congestive Heart Failure

Diuretics may lead to electrolyte abnormalities, especially sodium and potassium and/or thiamin deficiency (e.g., furosemide, chlorothiazide).

Cancer

Radiation, chemotherapy, and/or surgery can negatively affect nutritional status and metabolism.

Chronic Obstructive Pulmonary Disease (COPD)

Xanthine derivatives (e.g., theophylline) may result in anorexia and nausea.

Lower Respiratory Infections

Antibiotics (e.g., amoxicillin) may result in nausea, anorexia, diarrhea, and stomatitis.

Pain

Low-dose aspirin

Source: Based on American Academy of Family Physicians, Nutrition Screening Initiative, American Dietetic Association. *A Physician's Guide to Nutrition in Chronic Disease Management for Older Adults*. Waldorf, MD: 2002.

potential consequences of trying to eliminate bitter taste are not. It may take some creative probing to assess medication compliance and potential nutritional implications.

Some medications lead to unintentional weight loss, while others such as steroids lead to undesired weight gain. Table 19.14 describes nutritional implications associated with medications used to treat diseases that are prevalent in older adults.

19.13 Low Body Weight/ Unintentional Weight Loss

Definition

There is no consensus or universal definition for underweight in older adults. Individuals with weights falling at the lowest percentiles of this age group can be defined as *underweight*. Individuals who have been thin and healthy for a lifetime face increased health risks when they lose muscle or other lean tissue.

BMI scores allow characterization of underweight across populations. A BMI falling into the lowest percentile of a reference standard in a comparable population can help identify nutritional risks. NHLBI defines underweight as a BMI <18.5 kg/m^2 for all adults,[114] while the WHO further defines levels of underweight as grades of "thinness."[115]

BMI 17.0–18.49 indicates grade 1 thinness

BMI 16.0–16.99 indicates grade 2 thinness

BMI <16.00 indicates grade 3 thinness

As discussed in the section on obesity, there is disagreement on what constitutes the lower BMI cut-points in older adults. Many national and international organizations and researchers have defined underweight with BMI. The results of a 2014 meta-analysis showed that the risk of mortality in older adults increased with a BMI of <23.0.[47] Although BMI remains an anthropometric measurement tool for assessing health status, unintentional weight loss is a validated indicator of malnutrition and has been associated with increased mortality. Unintended weight loss is defined by the Minimum Data Set as weight loss of 5 percent or more of body weight within the previous 1 month and 10 percent within 6 months.[116]

Etiology and Effects

Unintentional weight loss may be an indicator of an underlying, undiagnosed disease that alters biochemical and physiologic mechanisms, which, in turn, affect functional status and appetite. Underlying causes of unplanned weight loss and low body weight may include protein–calorie malnutrition, illness, poverty, and functional decline. (Refer to Case Study 19.2.) Changes in taste and smell, whether due to aging or medication use, can turn eating into a chore. Restrictive diets (low salt, low cholesterol, diabetic) have also been linked to malnutrition.[117] Anorexia (no appetite) and cachexia (chronically lacking appetite) lead to sarcopenia (muscle loss).

Weight loss after 65 or 70 years of age may be due in part to the blunted appetite and satiety signals of older

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Case Study 19.2 Ms. Dawson: A Senior Suffering Through a Bad Stretch

About to turn 81, Janice Dawson is 5 ft 6 in. tall and weighs 106 lb. She has had Parkinson's disease for 5 years, but that is not what concerns her. Her problem is pain from arthritis and lack of energy. She saw an ad on television for a vitamin–mineral supplement with ginseng that promises "more energy." Her son also told her to take a liquid dietary supplement to "feel better." Eighteen months ago, she had successful surgery for colon cancer, which was followed by chemotherapy treatments. She is now free of cancer. After the cancer treatment, she fell and broke a hip. This healed well, but serious leg pains started shortly afterward. There seems to be no cause for the pain, and a cure is unavailable. She is no longer able to take her walks through the neighborhood or tend her prize-winning garden. She would like to weigh 118 pounds again (her "usual") and is seeking nutritional counseling to try to regain some of her energy.

Questions

1. What are some of the nutritional issues faced by Ms. Dawson? (*Hint:* Calculate her current weight compared to her usual body weight as a percentage.)
2. How would you prioritize these in a nutritional care plan?
3. Calculate her energy needs and suggest strategies she might use to regain some energy.
4. What other information would you want to know in order to counsel Ms. Dawson?



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adults. Just as the thirst mechanism becomes less sensitive to dehydration, the response to eating after caloric deprivation is less acute. Older adults have lower circulating levels of ghrelin, the signaling protein that stimulates appetite.[118] Fat tissue that accumulates as muscle is lost in sedentary older populations. Fat contains **adipocytokines** such as leptin, which suppress appetite. Circulating levels of leptin correspond to the amount of adipose tissue, so that someone with high body fat may have a reduced appetite.

For older adults, underweight is much more serious than overweight. Being thin has been related to increased incidence of diseases, but it is impossible to tell from the data whether thinness precedes or follows incidence of disease. Chronic malnutrition reduces immune response, muscle and respiratory function, and wound healing.

Nutrition Interventions

Avoiding unintentional weight loss is desirable but not always possible. A first step is to determine what caused the weight loss so that proper intervention is administered. Nutritional deprivation and insufficient dietary intake are the key risk factors for the development of pressure ulcers and impaired wound healing.[119]

In a systematic review of studies, which evaluated the effect of nutrition therapy in protein–energy malnutrition connected with multiple disorders in older adults, 20 studies noted an improvement in anthropometric or biochemical measures, and 10 studies reported an improvement in function. However, there was insufficient evidence to determine how nutrition therapy should be formulated due to inconsistent or uncertain treatment adherence.[120] In a systematic review of 22 studies reported by the Cochrane Library of individuals at risk of malnutrition, protein and energy supplementation produced a small but consistent weight gain (2–4 percent), reduced mortality, and shorter length of hospital stays.[121] Supplementation was associated with nausea, diarrhea, and other GI disturbances. Overall, medical nutrition therapy for a frail, malnourished person should occur in consultation with an experienced registered dietitian. Refeeding and rehydration are done gradually:

- *Calories:* Eat and exercise to build muscle mass, strength. A meta-analysis indicate that Harris–Benedict formula significantly underestimates daily needs in frail older adults with pressure ulcers[122] and supported the international recommendations for 30–35 kcal per kg body weight per day.[123]
- *Protein:* 1.0–1.5 g of protein per kg body weight is adequate; 1.5–2.0 g per kg per day in cases of severe depletion, balanced throughout the day. For adults with pressure ulcers and who are at risk of malnutrition, protein intake of 1.25 to 1.5 g/kg is recommended.[123,124] Exceptions are patients with renal or liver failure, who may need a protein restriction.
- *Fluid:* Drink 1 mL per kcal; rehydrate slowly (refer to the "Dehydration" section).

adipocytokines Adipose tissue secretes several signaling proteins, including the appetite suppressants adiponectin, leptin, and resistin.

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Connection: Fluid

8 oz = 1 cup = 240 mL (milliliters) = 240 cc (cubic centimeters)

A super-sized soda (32 oz) equals approximately 4 cups (or 4 × 240 = 960 mL). A 2-L bottle of soda provides a little more than 8 cups of fluid. Some foods also count as fluid. For example, soup, gelatin products, and sherbet are considered fluids.

19.14 Dehydration

Definition

Dehydration is the physiological state in which cell fluid loss interferes with metabolic processes. Normal urination does not cause dehydration. The clinical signs of dehydration come from a review of 38 potential indicators of dehydration in older adults (61–98 years old, median age 82; $n = 55$; half were free-living; half were admitted to the hospital emergency department from extended care).[124] Seven signs and symptoms were strongly related to dehydration, although *not* to patient age:

1. Upper-body muscle weakness
2. Speech difficulty
3. Confusion
4. Dry mucous membranes in nose and mouth
5. Longitudinal tongue furrows
6. Dry tongue
7. Sunken appearance of eyes in their sockets

These signs were also confirmed in a systematic review of maintaining oral hydration in older people.[125] Although regulation of body temperature is one of the functions of the body's water compartment, fever or elevated temperature did not identify dehydration status in Gross's study of individuals admitted to emergency rooms. However, fever or elevated temperature may be an indicator of impending dehydration.

A systematic review of studies to determine the diagnostic utility of a clinical symptom or combined symptoms, to screen for dehydration, showed limited evidence of effectiveness. The authors found no consistently useful single test among the 67 tests measured but recommended further testing of a combination of measures.[126] Dehydration can be measured as a percentage of body weight lost when normal body weight is known. Phillips and colleagues[127] defined dehydration as losing nearly 2 percent of initial body weight. This can occur after avoiding all fluids and eating only dry foods for 24 hours. Weight loss of 4 percent of normal weight would be hard to ignore unless the individual had a compromised mental or cognitive status. Flushed skin, nausea, and apathy or lack of energy occur when 4 percent of body weight is lost due to dehydration. Prevalence data are hard to gather because dehydration is usually temporary, and there is no simple or commonly used standard definition for diagnosing dehydration in older adults. For example, patients coming to a nursing home from a hospital may have I tubes, and chart notes may simply say, "The patient looks well hydrated."

antidiuretic hormone Causes kidneys to absorb more water from urine, resulting in increased blood volume.

Etiology

Aging itself does not cause dehydration, even though the percentage of total body water shrinks from infancy to old age. Dehydration occurs more often in the elderly as a result of illness or other problems. Older people are less sensitive in detecting thirst than are younger people, and they, therefore, may not think to drink. Once fluids are consumed, aging kidneys may lose the ability to concentrate urine, and the **antidiuretic hormone** may become less effective. Swallowing problems, depression, or dementia may cause individuals to avoid eating or drinking. Decreased mobility impairs older adults' access to water and subsequent ability to reach the bathroom. Fear of incontinence, in general, is another reason leading to decreased fluid intake and subsequent dehydration.

Effects of Dehydration

Dehydration increases the resting heart rate and susceptibility to urinary tract infection, pneumonia, and pressure ulcers; it also leads to confusion, disorientation, and dementia. Because confusion and delirium may be signs of—as well as risk factors for—dehydration, consuming adequate fluids can become a vicious circle for someone at risk for cognitive decline.

Nutritional Interventions

The Institute of Medicine's DRI for water does not change as adults get older: "The AI for total water (drinking water, beverages, and foods) for the elderly is set based on median total water intake of young adults."[128] Some health professionals suggest fluid levels to be 1 mL per calorie eaten, with a minimum of 1,500 mL per day (approximately 6 cups). The ultimate beverage is *water*—tap or flavored, *not* sugared. Water is generally accessible, adds no calories to the diet, provides traces of minerals needed for metabolism, and is very low in sodium, even when softened. Pure water does not provide energy, but lacking water to the point of dehydration dramatically reduces an individual's energy.

Many beverages contribute nutrients as well as fluid:

1. Tea, especially green tea, contains flavonoids that have been linked to heart health.[129]
2. Coffee (115 mg/8 fl oz) and black tea (90 mg/8 fl oz) contain potassium for electrolyte balance. The DRI for older adults is 4,700 mg, but small contributions add up.

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3. Milk provides much-needed high-quality protein, calcium, riboflavin, and vitamin D. Other protein drinks might be made from fruit blended with yogurt, whey powder, or nut butters.
4. Regular use of cranberry juice reduces urinary tract infections in women.[130]
5. Fruit and vegetable juices count as part of the recommended fruit and vegetable servings.

Rehydrate Slowly

To treat dehydration in older adults, replace fluids slowly. Guidelines are to provide roughly one-fourth to one-third of the overall fluid deficit each day in the form of water or a 5 percent glucose solution (when the individual's blood values are stable).[126] For individuals with swallowing problems, or dysphagia, thickened liquids count as fluid. When bedridden older adults are offered fluids hourly and also with medication, they achieve higher levels of hydration.[126]

Dehydration at End of Life

Dehydration can occur in people with terminal illness or who are near death. Some individuals stop eating and/or drinking hours, days, or even weeks before death. Dehydration at the end of life contributes to an overall slowing of body systems, including decreased production of body fluids, resulting in less congestion, less edema and ascites, and less GI action together with increasing levels of drowsiness. An individual may experience slight thirst, although many dying patients do not report being thirsty. They may experience dry mouth that can be alleviated by ice chips or artificial saliva. Decreased urine output can be a benefit because there is less need to go to the toilet. It is not known whether medically assisted hydration (provided via intubation) improves quality of life.[131] A survey of hospice nurses found that patients who stopped food and fluids usually died a "good" death within 2 weeks of refusing nourishment.[132] "Good" was measured on a nine-point scale that included variables for suffering, pain, peacefulness, and overall quality of death and based on the nurses' perceptions.

19.15 Bereavement

Bereavement is the loss felt when someone who is personally significant dies. Losses of friends and family members happen more often in the lives of older persons. Grief, a very powerful emotion, is a natural response to bereavement. The grieving process, with its stages of shock and denial, disorganization, volatile reactions, guilt, loss and loneliness, relief, and reestablishment,[133] diverts attention from normal activities. Shopping and food preparation, eating, and drinking may be ignored in the grieving process. Any loss of long-shared relationships through death, dementia, or moving brings about lack of interest in activities surrounding meal planning, preparation, shopping, and eating. People who are in mourning are vulnerable to malnutrition.

Widowhood has been shown to trigger disorganization and changes in daily routine, especially related to food preparation and eating.[134] Widowed people who are able to enjoy mealtimes, have good appetites, have higher-quality diets, and receive social support work through the grieving process have fewer health consequences (Photo 19.1).



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Photo 19.1 Grief can have a negative impact on diet.

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Key Points

1. About three of four older adults consider their health to be good, very good, or excellent, despite the high prevalence of chronic disease in older adults.
2. Hypertension, which affects more than two-thirds of older adults, can be moderated with the DASH diet; further blood pressure reductions can be achieved by restricting sodium intake in addition to following the DASH eating pattern.
3. Of adults over the age of 65, 29 percent have diabetes, primarily type 2, which has an impact on many other conditions and suggests the importance of lifestyle and diet modifications.
4. Body mass index should be combined with other measures such as waist circumference to assess weight status in older adults; a BMI range of 23–27 seems reasonable for older adults.
5. Bed rest and inactivity is detrimental to strong bones. Exercise combined with good nutrition—including adequate calcium and vitamins D, C, and B_6—helps to maintain bone mass density.
6. Polypharmacy is a risk factor for malnutrition and may contribute to poor oral health; dry mouth and the associated gingival disease can result from medications (such as antihistamines, antidepressants, sedatives, and antianxiety drugs).
7. Despite adequate dietary intake of vitamin B_{12}, older adults may still have low blood levels due to malabsorption. Monitoring B_{12} blood levels in vulnerable populations can help prevent the irreversible nerve damage caused by B_{12} deficiency. Vitamin B_{12} is one instance when the synthetic version of a vitamin is better absorbed than the food-bound version.
8. Osteoarthritis is the most common inflammatory disease of older adults. Weight loss helps to reduce the load exerted on knees and also reduces risk of developing osteoarthritis.
9. Dementia associated with old age can be due to vascular and degenerative diseases, physical trauma and infection, depression, and malnutrition. However, most of the dementia in older adults in the United States is associated with Alzheimer's disease. Nutritional efforts focus on treatment of underlying causes and maintaining quality of life.
10. Weight loss in an older adult signals potential illness and malnutrition; an individual who is losing weight without trying needs a thorough assessment.
11. Confusion and muscle weakness related to dehydration are avoidable. Adequate fluid intake prevents dehydration and can also contribute needed nutrients to the diet of an older adult, such as calcium, vitamin D, protein, and riboflavin from milk; antioxidants from tea and coffee; and vitamins, minerals, and fiber from juices. Socializing over a beverage may add to quality of life. Some long-term care institutions have implemented "happy hour" programs to encourage fluid intake.

Review Questions

1. What are the three most common chronic conditions affecting **men** over the age of 65?
2. What are the three most common chronic conditions affecting **women** over the age of 65?
3. BMI is a less effective predictor of morbidity and mortality in older than younger adults. Why is BMI a less reliable tool in older adults?

In questions 4–8, determine whether the statement is true or false.

4. The DASH diet has been shown to reduce HBP; additional sodium restrictions have led to further reductions in blood pressure.

   _____ True _____ False
5. Even a small loss of body weight can improve OA.

   _____ True _____ False
6. Vitamin K levels present in dark-green vegetables may interfere with warfarin (anticoagulant) therapy.

   _____ True _____ False
7. Eating a Mediterranean-style diet is associated with lower CVD mortality in older adults.

   _____ True _____ False
8. Older adults who suffer from sarcopenia may benefit from high-protein diets. High protein intake will also help to keep their bones strong.

   _____ True _____ False
9. Vitamin B_{12} deficiency can cause irreversible neurological damage. List at least three reasons why an older adult might have low vitamin B_{12} levels.
10. Dehydration can result in confusion. List three or more strategies that can help to restore hydration and provide nutrients an older adult might be missing.

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Answers to Review Questions

Chapter 1

1. True
2. False
3. False
4. False
5. True
6. Answers consist of pregnant women, breastfeeding women, infants, growing children, frail older people, ill people, and people recovering from illness.
7. True
8. False
9. True
10. True
11. a
12. True
13. False
14. False
15. True
16. True
17. True
18. d
19. a
20. c

Chapter 2

1. b
2. True
3. False
4. True
5. d
6. a
7. i
8. b
9. c
10. h
11. f
12. e
13. g
14. False
15. True
16. False
17. d
18. True
19. True
20. False
21. True
22. False
23. True
24. False
25. False
26. False
27. False
28. True
29. c

Chapter 3

1. True
2. False
3. True
4. False
5. False
6. False
7. True
8. True
9. True
10. False
11. False
12. True
13. True
14. False
15. True
16. True
17. True
18. True
19. True
20. True
21. False
22. True
23. False
24. False

Chapter 4

1. c
2. True
3. 4 lb 10 oz
4. False
5. False
6. a
7. d
8. a
9. b
10. True
11. False
12. True
13. True
14. False
15. False
16. True
17. False
18. True
19. True
20. c
21. False
22. a
23. 130 nmol/L
24. 193 pmol/L
25. 911 nmol/L
26. True
27. False
28. False
29. c
30. True
31. False
32. True
33. False

Chapter 5

1. True
2. True
3. False
4. False
5. False
6. True
7. False
8. d
9. True
10. False
11. True
12. False
13. True
14. False
15. True
16. False

Chapter 6

1. d
2. a
3. c
4. b

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5. c
6. b
7. c
8. a
9. c
10. Lactogenesis 1: the first stage of milk production that extends into the first few postpartum days when suckling is not needed for milk production. Lactose and protein content of milk increases.

    Lactogenesis II: begins 2–5 days' postpartum and continues to about 10 days' postpartum. This is when milk comes in, the lactose and fat composition are increasing, the protein content is decreasing, and the volume of milk produced is increasing.

    Lactogenesis III: begins about 10 days' postpartum and milk composition becomes stable.
11. Correct answers include:
    - The balance of nutrients in human milk matches human infant requirements for growth and development closely; no other animal milk or human milk substitute (HMS) meets infant needs as well.
    - Human milk is isosmotic (of similar ion concentration; in this case human milk and plasma are of similar ion concentration) and therefore meets the requirements for infants without other forms of food or water.
    - The relatively low protein content of breast milk compared to cow's milk meets the infant's needs without overloading the immature kidneys with nitrogen.
    - Minerals including iron and zinc are provided in a form that is highly available.

Chapter 7

1. Trauma from poor positioning, poor latch, improper release of suction after a feeding, infection, thrush, incorrect flange size during pumping, or too much pressure while pumping and disorganized or dysfunctional suck.
2. d
3. Development after cracked or sore nipples, missing a feeding or mom sleeping through the night, restrictive clothing or a tight bra.
4. True
5. True
6. True
7. False
8. Jaundice observed in the first 24 hours of life, blood group incompatibility or hemolytic disease, gestational age 35–36 weeks, previous siblings received phototherapy, significant bruising, exclusive breastfeeding when not going well and/or excessive weight loss, and East Asian race.
9. d
10. d

Chapter 8

1. b
2. c
3. d
4. c
5. a
6. Correct answers include increases gastrointestinal distress, increases gastroesophageal reflux, stifles infant hunger and fullness cues, increases spitting up.
7. c
8. d.
9. The correct answers include responding appropriately to the infant's hunger and satiety cues, recognizing the infant's developmental abilities and feeding skills, fostering the infant's abilities to initiate and guide feeding and mealtime interactions, and providing pleasant eating environments.

Chapter 9

1. c
2. a
3. True
4. False
5. False
6. False
7. The correct answers include phenylketonuria and galactosemia.
8. The correct answers include disorders that impact brain growth, side effects of medications, altered body composition, increased or decreased energy expenditure.
9. Correct answers include nasogastric feeding, orogastric feeding, parenteral feeding, and gastrostomy tube feeding.

Chapter 10

1. c
2. d
3. e
4. a
5. True
6. d
7. - Whole-grain breads and cereals.
   - Fruits and vegetables.
   - Low-fat dairy products.
   - Lean meats, fish, and beans.
   - Limited amount of sweetened beverages and sweets.
8. Physical activity plays a role in maintaining energy balance.

   Physical activity helps to build muscle strength.

   Being physically active is a healthy lifestyle behavior that is important to establish at a young age.

   Appropriate activities for children include riding a tricycle or bicycle, walking, skipping, running, and active play.

   Limiting screen time and moving screens from young children's bedrooms is also recommended.

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Chapter 11

1. c
2. d
3. c
4. a
5. True
6. True
7. False
8. Correct answers include to identify a decreasing rate of head growth, because any change in brain growth can impact weight and height (or length) growth, conditions such as spastic quadriplegia, cerebral palsy, Rett syndrome, Prader–Willi syndrome, or Down syndrome.
9. Correct answers include offering food textures that make the child a successful eater, allowing a monotonous diet if required for limited oral feeding skills, allowing a bottle longer than expected due to developmental delays requiring it.
10. Correct answers include when a child has to have a restricted diet, such as a result of allergies; when medications cause side effects that lower appetite; when a child has behaviors that limit food choices, such as autism, Prader–Willi syndrome; treatment with a calorie-restricted diet.

Chapter 12

Timothy, in Case Study 12.1, returns to his pediatrician 6 months later at 7½ years of age for a weight check. He has gained 10 kg in 6 months and now weighs 90 lb (41 kg). His height has increased to 51 in. (130 cm).

1. Body mass index (BMI) = weight in kg divided by height in meters squared; 41 kg divided by 1.69 = 24.26 kg/m^2.
2. >95th percentile for his age and gender.
3. d. To classify obesity above the 95th percentile, divide the child's BMI by the 95th percentile. BMI: 24.26/19.6 × 100 = 124% of 95th percentile BMI for age, classified as Class II obesity.
4. Timothy would enter the Prevention Plus approach to treatment for 3–6 months. If he maintains his weight or his BMI-for-age percentile is deflecting down, he would continue the Prevention Plus. If he gains weight, the next approach would be a structured weight management program. If he has weight loss or his BMI-for-age percentile deflects down, he would continue the structured weight management program. If he continues to gain weight, then he would enter a comprehensive multidisciplinary intervention.
5. d
6. Find a safe route for walking or biking to school.

   Encourage at least 60 minutes of active play per day.

   Work within the community to maintain parks and other safe places for children to play.

   Child can participate in organized sports that are appropriate for his stage of development and physical abilities.
7. Decrease "screen time" to less than 2 hours per day.

   Remove televisions, video games, and computers from children's bedrooms.

   Be active as a family.
8. c

Chapter 13

1. c (the other conditions are not known to impact growth directly).
2. b (because this child would have a change in body composition).
3. c (as this is the only answer having to do with limited activity).
4. b
5. True
6. True
7. False
8. Examples of support services for families are maternal and child health services, school nutrition programs, and school educational programs.
9. Correct answers include medication side effects and ability to concentrate or attend to meals.
10. An individualized education plan (IEP) is a school educational plan that could include feeding or eating assistant, access to snacks or meals at set times at school, and selection of foods appropriate for the child's abilities or condition.

Chapter 14

1. a
2. False
3. d
4. False
5. b
6. b
7. Biological age is based on sexual maturation rating. It assesses the degree of physical development, which can vary greatly among individuals of the same gender and age, thus is a better indicator of the nutrient needs of individuals as it provides a physiological estimate of needs based on growth velocity, body composition, and reproductive capacity.
8. d
9. d

Chapter 15

1. c
2. a
3. d
4. d
5. c
6. While both conditions include eating large amounts of food in a short period of time, a diagnosis of bulimia nervosa requires frequent purging methods to compensate for the calories consumed while the diagnosis of binge-eating disorder does not include a criterion for purging.

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7. Energy intake that results from the consumption of alcohol may displace energy intake from food. Because alcohol does not provide micronutrients, the overall dietary quality would be reduced in an individual who consumed alcohol frequently. The use of tobacco increases vitamin C requirements. The use of recreational drugs may result in increased intakes of snack foods and other highly refined simple carbohydrates that are high in sodium and fat and low in micronutrients.

Chapter 16

1. Individual factors—Things individuals are primarily responsible for, include food and nutrient intake and nutritional adequacy, physical activity and other lifestyle habits; and the results of individual behavior on weight status and chronic disease risk factors. These are monitored at the individual level using standard indicators, summarized across population groups, and compared to national Healthy People 2030 objectives.

   External or environmental factors—Things that are the result of decisions made by planners, retailers, employers, and healthcare providers and others that affect the environments in schools, worksites, and the community; as well as the social environment (support systems, income, education, discrimination), physical environment (housing, transportation, location of retail stores, and restaurants), and availability and quality of health and nutrition services. These are monitored at the local community, state, and federal levels and compared to Healthy People 2030 objectives.
2. Bone density and muscular strength peak by age 30. By middle adulthood, there is a loss in muscle mass and an increase and redistribution of body fat. With the decline of estrogen production bone loss is accelerated, abdominal fat increases and blood cholesterol and triglyceride levels raise. Risk for hypertension, insulin resistance, diabetes, stroke, gallbladder disease, and coronary artery disease increase with the accumulation of additional body fat. These changes shift the person from resilient and healthy with metabolic homeostasis to observable physiologic and metabolic alteration and the development of clinical conditions and chronic diseases.
3. Caloric needs can be determined by using reference tables, measured through indirect calorimetry, and calculated using an established energy calculation formula or the simple method of 15 cal per lb of body weight. Factors that decrease calorie needs are sedentary lifestyle, and aging with declines in metabolic rate and loss of muscle mass. Calorie needs are increased by physical activity, and by increases in weight and muscle mass.
4. Males consume too much total and saturated fat, cholesterol, total sugar, and sodium and not enough fiber; vitamins A, C, D, E, and K; choline; calcium; magnesium; and potassium. Females have too much saturated fat, total sugar, and sodium and low intakes of fiber; vitamins A, D, and E; choline; calcium; iron; magnesium; and potassium. Inadequacies and excesses alter substrate availability, cause imbalances at the cellular and subcellular levels, and result in changes in tissues such as bone, blood vessels, skin, and mucosal membranes.
5. Considerations include priority health issues and nutrient needs of young adults and older faculty and staff, and current Dietary Guidelines for Americans. The challenge on college campuses is to provide nutrient-dense foods, minimize solid fats and added sugars, and offer appropriate serving sizes while taking into account product availability, cultural and taste preferences, convenience, and cost. Education messages should include guidance on what and how much to eat, and could incorporate components of the Eating Competence Model. You might consider environmental changes and policies to support healthful food choices and opportunities for physical activity.
6. Compare your current level of activity with the national guidelines on Table 16.10. Being more physically active increases muscle strength, balance, and endurance; supports physical and mental health; improves cognitive function; helps manage weight and combat weight gain; reduces blood cholesterol and blood pressure; and helps prevent the onset or progression of several chronic diseases. Sedentary lifestyle results in the loss of these benefits.
7. Individuals—Education and counseling to increase knowledge and encourage behavior change, primary care providers assessing and talking about BMI, eating habits, and physical activity.

   Organizations—Health promotion programs, sponsored events, community gardens, food shelves, and policies about types of foods served in cafeteria and events.

   Environmental Changes—Increased access to grocery stores, farmers markets and community gardens, healthful food and beverage choices vending machines, point of purchase signage about calories and fat content.

   Product Development and Marketing—functional foods, front-of-package food rating symbols, smaller package, and serving sizes.

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Policies—Enrichment of foods, food labeling and health claims, and nutrition programs to improve food security.

Chapter 17

1. Essential components of cognitive behavioral change programs include:
   - Long duration—programs are 12–16 weeks long to build knowledge, modify beliefs and attitude, and integrate new behaviors.
   - Combination of skills training and analysis of behavior and thought processes.
   - Two key features are helping the client recognize and replace automatic and irrational thoughts and beliefs (cognitive restructuring) and increasing awareness and control of cues associated with eating (stimulus control).
   - Strategies include setting realistic goals, calorie deficit if needed for weight loss, individualized meal plan that includes variety of enjoyed foods and fits lifestyle and budget, skills development, problem solving, self-management, cognitive restructuring, stress management, having a support system, and regular exercise, followed by maintenance support—all directed to long-term effectiveness.
2. Differences between recommendations to reduce risk of the population and treatment of high-risk individuals:
   - Population messages vs. individualized behavioral counseling and ongoing intervention with health care providers to help make therapeutic lifestyle changes.
   - Cardio-protective diet that emphasizes plant foods and is similar to Dietary Guidelines for Americans vs. tighter restrictions on dietary fats and cholesterol intake and higher amounts of fiber with emphasis on viscous fiber.
   - Pharmacotherapy is often added for high-risk individuals to lower LDL cholesterol and reduce plaque formation on the lining of arterial walls.
3. Abdominal obesity, high blood pressure, elevated fasting glucose, dyslipidemia with elevated LDL cholesterol, low HDL, and high triglycerides. Three are needed for a diagnosis of metabolic syndrome. Waist circumference is a simple screening method.
4. There is a long pre-symptomatic phase with marginally elevated glucose during which vascular changes occur. Intervention in the prediabetes phase can prevent conversion to diabetes and reduce cardiovascular risk factors.
5. Diet flexibility within an individualized plan. This includes a target calorie level based on current weight and weight goal, with a defined distribution of calories among carbohydrate, protein, and fat. A meal plan including snacks that provides relatively stable carbohydrate intake throughout the day. A variety of food to meet basic nutrient needs (RDA and DRI) and is consistent with healthy eating/cardio-protective diet (Dietary Guidelines for Americans).
6. Prevention—Healthy diet with caloric intake adjusted to achieve or maintain weight within normal ranges.

   Treatment—Medical nutrition therapy to restore nutrient shortages, maintain nutritional health, and prevent or manage complications of cancer and the side effects of treatment.

   Remission—Healthy diet with caloric intake adjusted to achieve or maintain weight within normal ranges.

   Advanced Stages of Cancer—Food and fluid intake adjusted to meet patient wishes and manage symptoms and improve quality of life.
7. True
8. True
9. False
10. False
11. Total cholesterol, smoking status, and blood pressure.
12. Reduce caloric intake, while emphasizing foods that are compatible with a cardio-protective diet, and increase physical activity to lose weight. She should get 30 minutes of moderate physical activity most days of the week and work up to longer duration or greater intensity as she is able.
13. Common themes:
    - Maintain a healthy weight—if overweight, this means a weight loss of 5–10 percent of body weight. For HIV disease, the focus is on maintaining weight and maintaining lean body mass.
    - Avoid or reduce central or abdominal adiposity because this is associated with insulin resistance and hyperglycemia, hyperlipidemia, metabolic syndrome, cardiovascular disease, and type 2 diabetes.
    - A healthy, cardioprotective diet emphasizes plant foods (vegetables, fruit, whole grains, legumes), healthy fats, low-fat dairy products, and lean meats. *Trans* fat is avoided and saturated fat is limited to 7 percent of calories; and intake of sweets and red meats is minimized.
    - Choosing a "healthy diet," being physically active, and maintaining a healthy weight can help prevent the development of chronic disease and delay complications.

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- Regular physical activity at a moderate or vigorous level is important because it aids weight loss and maintenance and improves insulin/glucose profile, as well as reducing lipids and blood pressure.
- Be screened and "know your numbers" (BMI, waist circumference, blood lipid levels, blood glucose, and blood pressure) to be aware of risk level and perhaps be motivated to take action.
- Lifestyle changes often require intensive, ongoing intervention.

Chapter 18

1. True
2. True, lifestyle factors are estimated to account for 51 percent of longevity compared to a 19 percent contribution from genetics.
3. False
4. False. [It's a trick question] While energy needs decrease with age, vitamin and mineral needs remain the same or increase, such as vitamin D and calcium.
5. True
6. Here are seven factors that put older adults at risk of malnutrition: (1) food insecurity or low income; (2) eating fewer than two meals per day; (3) illness or a condition that has affected dietary intake; (4) lost or gained more than 10 lb in the last 6 months; (5) polypharmacy; (6) BMI below 19; and (7) physical limitations to shop, cook, and feed self.
7. Here are three adjustments of generic food guides to make for older adults: (1) greater risk of dehydration requires fluid assessment and recommendations; (2) lower caloric intake needs to be balanced with greater nutrient density, especially when activity level is low; and (3) guidance needs to ensure adequate protein intake.
8. Reasons might include lack of money that may affect ability to buy high-quality protein, compromised ability to chew, inability to cut meats once cooked, and cognitive impairment that leads to forgetting to eat.
9. Multiply 107 kg by 0.8–1.3 g protein per kg body weight; distribute the 86–139 g of protein that would be adequate for JT throughout the day in a way that he would consume as food and beverages; use heart-healthy protein sources.

Chapter 19

1. Hypertension, arthritis, and heart diseases.
2. Hypertension, arthritis, and heart diseases; in other words, older men and women face the same chronic diseases.
3. The BMI is calculated using height and weight. Getting an accurate height may be more difficult in older adults who have compressed vertebrae or kyphosis which has reduced normal height. On average, older adults have lost muscle tissue which has been replaced with fat tissue and BMIs were developed with measurements of younger adults. Dehydration can introduce further errors into the interpretation of a BMI in an older individual. Thus, less weight may be due to less muscle and body water.
4. True, adherence to the DASH diet reduces blood pressure. An additional dose–response effect on blood pressure reduction results from sodium restriction.
5. True
6. True. Approximately 11 percent of men over age 65 and 4.5 percent of women over age 65 take warfarin and must keep their vitamin K levels stable for effective blood-thinning effect.
7. True
8. True
9. Vitamin B_{12} deficiency may result from malabsorption due to atrophic gastritis, GI infections such as *H. pylori*, lack of animal products in the diet, family history of pernicious anemia, and medications.
10. Push fluids by structuring reminders to drink (such as a water jug in the refrigerator that should be empty at day's end), drinking liberal amounts of water when taking medications, offering nutritious beverages to increase nutrients, observing "happy hour" as a time to socialize and consume fluids, and perhaps most importantly for many older women, deal with fears related to incontinence by fixing underlying structural problems and doing exercise (Kegels).

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Appendix A

Measurement Abbreviations and Equivalents

Metric or SI Unit	
Unit	**Abbreviation**
Kilogram	kg
Gram	g
Milligram	mg
Microgram	μg, mcg
Nanogram	ng
Meter	m
Centimetre	Cm
Millimetre	Mm
Liter	L
Decilitres	dL
Millilitre	mL
Millimole	mmol
Micromole	μmol
Picomole	pmol

Nonmetric	
Unit	**Abbreviation**
Ounce	Oz
Pound	Lb
Tablespoon	Tbsp
Teaspoon	Tsp
Cup	cup
Pint	Pt
Quart	Qt
Gallon	Gal
Inch	in
Foot	Ft
Yard	Yd

Equivalents		
Weight: Metric		
1 kilogram	=	2.2 pounds; 1000 grams
1 gram	=	0.035 ounce; 1000 milligrams
1 milligram	=	1000 micrograms
1 microgram	=	1000 nanograms
Weight: Nonmetric		
1 ounce	=	28.35 grams
1 pound	=	0.45 kilograms; 454 grams
Linear		
1 millimeter	=	0.039 inch
1 centimeter	=	0.01 meter; 0.39 inch
1 meter	=	100 centimeters; 39.4 inches; 3.28 feet
1 inch	=	2.54 centimeters; 0.025 meter
1 foot	=	30.5 centimeters; 0.31 meter
1 yard	=	3 feet; 0.91 meters

Fluid Volume		
1 teaspoon	=	5 mL
1 tablespoon	=	15 mL; 0.5 ounce; 3 teaspoons
1 ounce	=	30 mL; 29.57 grams; 6 teaspoons; 2 tablespoons
1 cup	=	240 mL; 8 ounces; 48 teaspoons; 16 tablespoons
1 pint	=	480 mL; 2 cups; 16 ounces; 1 pound ("A pint is a pound the whole world round.")
1 quart	=	0.95 liter; 2 pints; 4 cups; 32 ounces; 2 pounds
1 liter	=	1.06 quarts; 1000 mL
1 gallon	=	3.79 liters; 4 quarts; 8 pints; 16 cups; 8 pounds ("Two cups in a pint, two pints in a quart, four quarts in a gallon.")

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Appendix A

Conventional Units and SI Units[a]			
a. To convert conventional units to SI units, multiply by the conversion factor. b. To convert from SI units to conventional units, divide by the conversion factor.			
	Conventional Units	**Conversion Factor**	**SI Units**
Calcium	mg/dL	0.25	mmol/L
Cholesterol	mg/dL	0.0259	mmol/L
HDL cholesterol	mg/dL	0.0259	mmol/L
Ferritin	ng/mL	2.247	pmol/L
Folate	ng/mL	2.266	nmol/L
Glucose	mg/dL	0.0555	mmol/L
Hematocrit	%	0.01	Proportion of 1.0
Hemoglobin	g/dL	10.0	g/L
Homocysteine	mg/L	7.397	μmol/L
Insulin	μIU/mL	6.945	pmol/L
Iron	μg/dL	0.179	μmol/L
LDL cholesterol	mg/dL	0.0259	mmol/L
Lipoprotein (a)	mg/dL	0.0357	μmol/L
Triglycerides	mg/dL	0.0113	mmol/L
Vitamin A (retinol)	μg/dL	0.0349	μmol/L
Vitamin E	μg/dL	0.0232	μmol/L
Vitamin B_6	ng/mL	4.046	nmol/L
Vitamin B_{12}	pg/mL	0.738	nmol/L
Vitamin C	mg/dL	56.78	pmol/L
Vitamin D	ng/mL	2.5	nmol/L

[a] "SI" stands for *le Système International d'unités*. SI values are based on decades of international cooperation in developing a universal system of measurement.

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Appendix B

Body Mass Index (BMI)

Body Weight (pounds)

Height	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
4′10″	86	91	96	100	105	110	115	119	124	129	134	138	143	148	153	158	162	167	172	177	181	186	191	196	201	205	210	215	220	224	229	234	239	244	248	253	258
4′11″	89	94	99	104	109	114	119	124	128	133	138	143	148	153	158	163	168	173	178	183	188	193	198	203	208	212	217	222	227	232	237	242	247	252	257	262	267
5′0″	92	97	102	107	112	118	123	128	133	138	143	148	153	158	163	168	174	179	184	189	194	199	204	209	215	220	225	230	235	240	245	250	255	261	266	271	276
5′1″	95	100	106	111	116	122	127	132	137	143	148	153	158	164	169	174	180	185	190	195	201	206	211	217	222	227	232	238	243	248	254	259	264	269	275	280	285
5′2″	98	104	109	115	120	126	131	136	142	147	153	158	164	169	175	180	186	191	196	202	207	213	218	224	229	235	240	246	251	256	262	267	273	278	284	289	295
5′3″	102	107	113	118	124	130	135	141	146	152	158	163	169	175	180	186	191	197	203	208	214	220	225	231	237	242	248	254	259	265	270	278	282	287	293	299	304
5′4″	105	110	116	122	128	134	140	145	151	157	163	169	174	180	186	192	197	204	209	215	221	227	232	238	244	250	256	262	267	273	279	285	291	296	302	308	314
5′5″	108	114	120	126	132	138	144	150	156	162	168	174	180	186	192	198	204	210	216	222	228	234	240	246	252	258	264	270	276	282	288	294	300	306	312	318	324
5′6″	112	118	124	130	136	142	148	155	161	167	173	179	186	192	198	204	210	216	223	229	235	241	247	253	260	266	272	278	284	291	297	303	309	315	322	328	334
5′7″	115	121	127	134	140	146	153	159	166	172	178	185	191	198	204	211	217	223	230	236	242	249	255	261	268	274	280	287	293	299	306	312	319	325	331	338	344
5′8″	118	125	131	138	144	151	158	164	171	177	184	190	197	203	210	216	223	230	236	243	249	256	262	269	276	282	289	295	302	308	315	322	328	335	341	348	354
5′9″	122	128	135	142	149	155	162	169	176	182	189	196	203	209	216	223	230	236	243	250	257	263	270	277	284	291	297	304	311	318	324	331	338	345	351	358	365
5′10″	126	132	139	146	153	160	167	174	181	188	195	202	209	216	222	229	236	243	250	257	264	271	278	285	292	299	306	313	320	327	334	341	348	355	362	369	376
5′11″	129	136	143	150	157	165	172	179	186	193	200	208	215	222	229	236	243	250	257	265	272	279	286	293	301	308	315	322	329	338	343	351	358	365	372	379	386
6′0″	132	140	147	154	162	169	177	184	191	199	206	213	221	228	235	242	250	258	265	272	279	287	294	302	309	316	324	331	338	346	353	361	368	375	383	390	397
6′1″	136	144	151	159	166	174	182	189	197	204	212	219	227	235	242	250	257	265	272	280	288	295	302	310	318	325	333	340	348	355	363	371	378	386	393	401	408
6′2″	141	148	155	163	171	179	186	194	202	210	218	225	233	241	249	256	264	272	280	287	295	303	311	319	326	334	342	350	358	365	373	381	389	396	404	412	420
6′3″	144	152	160	168	176	184	192	200	208	216	224	232	240	248	256	264	272	279	287	295	303	311	319	327	335	343	351	359	367	375	383	391	399	407	415	423	431
6′4″	148	156	164	172	180	189	197	205	213	221	230	238	246	254	263	271	279	287	295	304	312	320	328	336	344	353	361	369	377	385	394	402	410	418	426	435	443
6′5″	151	160	168	176	185	193	202	210	218	227	235	244	252	261	269	277	286	294	303	311	319	328	336														
6′6″	155	164	172	181	190	198	207	216	224	233	241	250	259	267	276	284	293	302	310	319	328	336	345														
	Underweight (<18.5)	Healthy Weight (18.5–24.9)						Overweight (25–29.9)					Obese (30–39.9)										Extreme Obesity (≥40)														

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Appendix B

Find your height along the left-hand column and look across the row until you find the number that is closest to your weight. The number at the top of that column identifies your BMI. The area shaded in blue-green represents healthy weight ranges. The figures below present silhouettes of various BMI.



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Editorial review has deemed that any suppressed content does not materially affect the overall learning experience. Cengage Learning reserves the right to remove additional content at any time if subsequent rights restrictions require it.

References

Chapter 1

1. What is food security? Available at ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/definitions-of-food-security.aspx. Last updated September 8, 2021.
2. DeParle, J. Vast expansion in aid kept food insecurity from growing last year. *The New York Times*. Sept. 8, 2021. Available at https://www.nytimes.com/2021/09/09/us/politics/vast-expansion-aid-food-insecurity.html, accessed February 25, 2023.
3. Tarasuk, V., Li, T., & Fafard St-Germain, A. A. Household food insecurity in Canada, 2021. Toronto: Research to identify policy options to reduce food insecurity (PROOF). August 16, 2022. Available at https://proof.utoronto.ca/, accessed February 25, 2023.
4. *Summary Report on Application of the DRIs for Dietary Assessment*. Washington, DC: National Academy of Sciences, 2000.
5. Applying Dietary Reference Intakes in Professional Settings. US Department of Health and Human Services: Office of Disease Prevention and Health Promotion. Available at https://health.gov/our-work/nutrition-physical-activity/dietary-guidelines/dietary-reference-intakes/applying-dietary-reference-intakes-professional-settings, accessed February 25, 2023.
6. Grabitske, H. A., et al. Low-digestible carbohydrates in practice. *J Am Diet Assoc*. 2008; 108:1677–1681.
7. Mysonhimer AR, Holscher HD. Gastrointestinal effects and tolerance of nondigestible carbohydrate consumption. *Adv Nutr*. 2022 Dec 22; 13(6):2237–2276. doi: 10.1093/advances/nmac094. PMID: 36041173; PMCID: PMC9776669.
8. McRorie, J. W., et al. Understanding the physics of functional fibers in the gastrointestinal tract. *J Am Acad Nutr Diet*. 2017; 117:251–264; 2020 Dietary Guidelines Advisory Committee. Advisory report to the Secretary of Health and Human Services and Secretary of Agriculture. Available at dietaryguidelines.gov/2020-advisory-committee-report. Published June 30, 2020.
9. Glycemic Index and Diabetes. Available at medlineplus.gov/eny/patientinstructions/000941.htm. Published October 18, 2020.
10. *Dietary Reference Intakes: Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids*. Washington, DC: National Academies Press, 2002.
11. Brand-Miller, J. C., et al. Glycemic index, postprandial glycemia, and the shape of the curve in healthy subjects: Analysis of a database of more than 1000 foods. *Am J Clin Nutr*. 2009; 89:97–105.
12. Atkinson, F. S., et al. International tables of glycemic index and glycemic load values 2021: A systematic review. *AmJ Clin Nutr*. 2021; 114(5): 1625–1632. doi: https://doi.org/10.1093/ajcn/nqab233.
13. Harris, W. S., et al. Omega-6 fatty acids and risk for cardiovascular disease. *Circulation*. 2009; 119:902–907. doi: https://doi.org/10.1161/circulationaha.114.012534|circulation.2014;130:1562–1564.
14. Position of the American Dietetic Association and Dietitians of Canada: Dietary fatty acids. *J Am Diet Assoc*. 2007; 107:1599–1611.
15. Marklund, M., et al. Biomarkers of dietary omega-6 fatty acids and incident cardiovascular disease and mortality. *Circulation*. 2019; 139: 2422–2436. doi: https://doi.org/10.1161/CIRCULATIONAHA.118.038908.
16. Hansel, B. Why dietary cholesterol is no longer enemy number one. *Medscape Diabetes & Endocrinology*. 19 March 2015. Available at www.medscape.com/viewarticle/841486?nlid=78597_1521&src=wnl_edit_medp_wir&uac=61213SX&spon=17, accessed February 25, 2023.
17. Thompson, M., et al. Omega-3 fatty acid intake by age, gender, and pregnancy status in the United States: National Health and Nutrition Examination Survey 2003–2014. *Nutrients*. 2019; 11:177. doi: 10.3390/nu11010177. PMID: 30650613; PMCID: PMC6356780.
18. Ordovas, J. M. Genetic influences on blood lipids and cardiovascular disease risk: Tools for primary prevention. *Am J Clin Nutr*. 2009; Suppl:1509S–1517S.
19. TransFat. 2018 May 18. Available at https://fda.gov/food/food-attitives-petitions/trans-fat, accessed February 26, 2023.
20. Countries with regulations against industrially produced trans fats tripled over the past year. *UN News Health*. Published December 7, 2021. Available at https://news.un.org/en/story/2021/12/1107382, accessed February 26, 2023.
21. Howes, M. J., & Simmonds, M. S. The role of phytochemicals as micronutrients in health and disease. *Curr Opin Clin Nutr Metab Care*. 2014 Nov; 17(6):558–566. doi: 10.1097/MCO.0000000000000115. PMID: 25252018.
22. Liu, R. H. Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. *Am J Clin Nutr*. 2003; 78:517S–520S.
23. Wolfe, K. L., et al. Cellular antioxidant activity of common fruits. *J Agric Food Chem*. 2008; 56:8418–8426.
24. Halvorsen, B. L., et al. Content of redox-active compounds in foods consumed in the United States. *Am J Clin Nutr*. 2006; 84:95–135.
25. *Dietary Reference Intakes: Water and Electrolytes*. Washington, DC: National Academies Press, 2004.
26. Kolasa, K. M. Water: The recommendations we give—Are they scientifically accurate? (Conference paper.) Food and Nutrition Conference and Exhibition, October 2002; American Dietetic Association.
27. Mayo Clinic Staff. Water: How much should you drink every day? Mayo Clinic Nutrition and healthy eating. Updated October 12, 2022. Available at https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-debth/water, accessed Februrary 28, 2023.
28. Corte, C., et al. People with marginal vitamin C status are at high risk of developing vitamin C deficiency. *J Am Diet Assoc*. 1994; 99:854–856.
29. Rowe, S., & Carr, A. C. Global vitamin C status and prevalence of deficiency: A Cause for Concern? *Nutrients*. 2020 Jul 6; 12(7):2008. doi: 10.3390/nu12072008. PMID: 32640674; PMCID: PMC7400810
30. Vitamin C (Ascorbic acid). Available at www.nlm.nih.gov/medlineplus/druginfo/natural/1001.html.
31. Lee, C., et al. Structural genomic variation and personalized medicine. *N Engl J Med*. 2008; 358:740–741.
32. Bookman, E. B., et al. Gene-environment interplay in common complex diseases: Forging an integrative model—Recommendations from an NIH Workshop. *Genet Epidemiol Publ*. doi: 10.1002/gepi.20571, accessed February 26, 2023.
33. Lin X. Genomic variation prediction: A summary from different views. *Front Cell Dev Biol*. 2021 Nov 25; 9:795883. doi: 10.3389/fcell.2021.795883. PMID: 34901036; PMCID: PMC8656232.
34. Williams, R. A., et al. Phenylketonuria: An inborn error of phenylalanine metabolism. *Clin Biochem Rev*. 2008; 29:31– 41.
35. Edens, A. C. Galactosemia. Updated May 2, 2021. Available at https://medlineplus.gov/ency/article/000366.htm, accessed March 3, 2023.
36. Hemochromatosis. Available at digestive.niddk.nih.gov/ddiseases/pubs/hemochromatosis. Updated January 2020. Accessed February 28, 2023.
37. Barker, D. J. Developmental origins of chronic disease. *Pub Health*. 2012; 126:185–189.
38. Shan Z., et al. Trends in dietary carbohydrate, protein, and fat intake and diet quality among US adults, 1999–2016. *JAMA*. 2019 Sep 24; 322(12):1178–1187. doi: 10.1001/jama.2019.13771. PMID: 31550032; PMCID: PMC6763999.
39. Popova S., et al. Fetal alcohol spectrum disorders. *Nat Rev Dis Primers*. 2023 Feb 23; 9(1):11. doi: 10.1038/s41572-023-00420-x. PMID: 36823161.
40. Kumar, N. B., et al. Green tea extract for prevention of prostate cancer progression in

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References

patients on active surveillance. *Oncotarget*. 2018 Dec 28; 9(102):37798–37806. doi: 10.18632/oncotarget.26519. PMID: 30701033; PMCID: PMC6340872. Available at https://www.ontarget.com/srticle/26519/text/4.

41. Boersma, P., Black, L. I., & Ward, B. W. Prevalence of multiple chronic conditions among US adults, 2018. *Prev Chronic Dis*. 2020; 17:200130. doi: http://dx.doi.org/10.5888/pcd17.200130external icon.
42. Mortality in the United States, 2021. NCHS Data Brief, Number 456, December 2022. Available at cdc.gov/nchs/products/databriefs/db456.htm.
43. World Cancer Research Fund/American Institute for Cancer Research. Diet, Nutrition, Physical Activity, and Cancer: A Global Perspective. Continuous Update Project Epert Report 2018. Available at https://www.wcrf.org/wp-content/uploads/2021/02/summary-of-third-expert-report.pdf, accessed March 5, 2023.
44. Sievenpiper, J. L., et al. Are sugar-sweetened beverages the whole story? *Am J Clin Nutr*. 2013; 98:261–263.
45. Bauer U. E., et al. Prevention of chronic disease in the 21st century: Elimination of the leading preventable causes of premature death and disability in the USA. *Lancet*. July 5, 2014; 384; 9937:45–52. doi: 10.1016/S01406736(14)60648-6.
46. Graudal, N., et al. Compared with usual sodium intake, low- and excessive-sodium diets are associated with increased mortality: A meta-analysis. *Am J Hyperten*. 2014; 27:1129–1137. doi: 10.1093/ajh/hpu028.
47. Oyebode O, et al. Fruit and vegetable consumption and all-cause, cancer and CVD mortality: Analysis of Health Survey for England data. *J Epidemiol Community Health*. doi: 10.1136/jech-2013-203500, accessed May 5, 2014.
48. Wang, X., et al. Fruit and vegetable consumption and mortality from all causes, cardiovascular disease, and cancer: Systematic review and dose-response meta-analysis of prospective cohort studies. *BMJ*. 2014; 349:g4490. doi: 10.1136/bmj.g4490.
49. Barrett, E. M., et al. Whole grain, bran and cereal fibre consumption and CVD: A systematic review. *Br J Nutr*. 2019 Apr; 121(8):914–937. doi: 10.1017/S000711451900031X. Epub 2019 Feb 14. PMID: 30761962.
50. Inflammation in Chronic Disease. March 2015. Available at www.cihr-irsc.gc.ca/e/43625.html, accessed April 16, 2015.
51. Furman, D., et al. Chronic inflammation in the etiology of disease across the life span. *Nat Med*. 2019 Dec; 25(12):1822–1832. doi: 10.1038/s41591-019-0675-0. Epub 2019 Dec 5. PMID: 31806905; PMCID: PMC7147972.
52. Hiza, HAB., et al. Position of the Academy of Nutrition and Dietetics: Total diet approach to healthy eating. *J Am Acad Nutr Diet*. 2013; 113:307–317.
53. The New Nutrition Facts Label. What's in it for you? 2022 April 13. Available at https://fda.gov/food/nutrition-education-resource-materials/new-nutrition-facts-label, accessed March 5, 2023.
54. Park, Y. K., et al. History of cereal-grain product fortification in the United States. *Nutr Today*. 2001; 36:23–36.
55. Gutierrez-Castrellon, P., et al. Diarrhea in preschool children and Lactobacillus reuteri: a randomized controlled trial. *Pediatrics*. 2014 Apr; 133(4):e904–e909. doi: 10.1542/peds.2013–0652.
56. Hajipour, A. The effects of dietary fiber on common complications in critically ill patients; with a special focus on viral infections; a systematic reveiw. *Immun Inflamm Dis*. 2022 May; 10(5):e613. doi: 10.1002/iid3.613. PMID: 35478440; PMCID: PMC9017620.
57. Doran, S. & Snydman, D. Risks and safety of probiotics. *Clin Infect Dis*. 2015 May 15; 60(Suppl 2):S129–S134. doi: 10.1093/cid/civ085.
58. Probiotics: Topic overview. Available at www.webmd.com/digestive-disorders/tc/probiotics-topic-overv, accessed August 20, 2017.
59. Bernhard, S., Borges, V., & Schedin, P. Vitamin D as a potential preventive agent for young women's breast cancer. *Cancer Prev Res*. 2021 Sep; 14(9):825–838. doi: 10.1158/1940-6207.
60. Kittler, P. G., et al. Diet counseling in a multicultural society. *Diabetes Educator*. 1989; 16:127–132.
61. IHSS Academy. Cultural_Consider_in_Nutrition_and_Food_Prep.pdf (ca.gov) Adapted from "Ethnic/Cultural Food Pyramids," www.fnic.nal.usda.gov/dietary-guidance and Images used with permission from Oldways: Health Through Heritage. Available at www.oldwayspt.org, accessed October 2013.
62. Freeland-Graves, J., et al. Position of the American Dietetic Association Total Diet Approach to Communicating Food and Nutrition Information. *J Am Diet Assoc*. 2002; 102:100–108.
63. Conti, K. The four winds nutrition model: A new culturally specific food guide and nutrition approach for the Northern Plains Indians. (Seminar presentation.) Minneapolis: University of Minnesota, October 28, 2002.
64. Dirks, R. T., et al. African American dietary patterns at the beginning of the 20th century. *J Nutr*. 2001; 131:1881–1889.
65. McCaffree, J. Dietary restrictions of other religions. *J Am Diet Assoc*. 2003; 103:912.
66. Dwyer, J. Dietary assessment. (1998). In M. E. Shils (Ed.), *Modern nutrition in health and disease* (pp. 937–962). Philadelphia, PA: Lippincott, Williams & Wilkins.
67. Gibson, R. S., Charrondiere, U. R., & Bell, W. Measurement errors in dietary assessment using self-reported 24-hour recalls in low-income countries and strategies for their prevention. *Adv Nutr*. 2017 Nov 15; 8(6):980–991. doi: 10.3945/an.117.016980. PMID: 29141979; PMCID: PMC5683000.
68. Bailey, R. L. Overview of dietary assessment methods for measuring intakes of foods, beverages, and dietary supplements in research studies. *Curr Opin Biotechnol*. 2021 Aug; 70:91-96. doi: 10.1016/j.copbio.2021.02.007. Epub 2021 Mar 11. PMID: 33714006; PMCID: PMC8338737.
69. Kirkpatrick, S., et al. Performance of the Automated Self-Administered 24-hour Recall relative to a measure of true intakes and to an interviewer-administered 24-h recall. *Am J Clin Nutr*. 2014; 100:233–240.
70. Automated self-administered 24-hour recall. January 2015. Available at appliedresearch.cancer.gov/asa24, accessed April 17, 2015.
71. Reedy, J. et al Evaluation of the Healthy Eating Index—2015. *J Acad Nutr Diet*. 2018 Sep; 118(9):1622–1633. doi: 10.1016/j.jand.2018.05.019. Erratum in: *J Acad Nutr Diet*. 2019 Aug 20; PMID: 30146073; PMCID: PMC6718954.
72. Green, R. Indicators for assessing folate and vitamin B-12 status and for monitoring the efficacy of intervention strategies. *Am J Clin Nutr*. 94 2 (2011):666S–672S.
73. Naska, A., et al. Dietary assessment methods in epidemiological research: Current state of the art and future prospects. F1000Research 2017, 6(F1000 Faculty Rev):926. doi: 10.12688/f1000research.10703.1.
74. Kranz, A., et al. Laboratory reference values. *N Engl J Med* 2004; 351:1548–1563.
75. Second National Report on Biochemical Status Indicators of Diet and Nutrition in the U.S. Population. CDC, National Center for Environmental Health, Division of Laboratory Sciences, March 27, 2012.
76. National Health and Nutrition Examination Survey. Available at www.cdc.gov/nchs/nhanes.htm, accessed March 12, 2023.
77. Statistics: Supplemental Nutrition Assistance Program. August 3, 2020. Available at https://www.ers.usda.gov/amber-waves/2020/august/taking-a-closer-look-at-supplemental-nutrition-assistance-program-snap-participation-and-expenditures, accessed March 12, 2023.
78. Food and Nutrition Assistance. Available at https://www.ers.usda.gov/topics/food-nutrition-assistance/, accessed March 12, 2023.
79. WIC Eligibility Requirements. Food and Nutrition Services. Available at www.fns.usda.gov/wic/wic-eligibility-requirements, accessed June 19, 2020.
80. Andreyeva, T., et al. The positive effects of the revised milk and cheese allowances in the special supplemental nutrition program for women, infants, and children. *J Acad Nutr Diet*. 2014; 114:622–630.
81. Position of the American Dietetic Association: Child and adolescent food and nutrition programs. At *J Acad Nutr Diet*. 2018; 118(8):1490–1497.
82. *Healthy People 2030*. Available at www.healthypeople.gov, accessed December 19, 2022.

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References

83. A Series of Systematic Reviews on the Relationship Between Dietary Patterns and Health Outcomes. Available at www.nel.gov/vault/2440/web/files/DietaryPatterns/DPRptFullFinal.pdf, accessed March 2014.
84. *Dietary Guidelines for Americans, 2020–2025*. Available at health.gov/dietaryguidelines/2020/guideline, accessed March 15, 2023.
85. Cho, S. S., et al. Consumption of cereal fiber, mixtures of whole grains and bran, and whole grains and risk reduction in type 2 diabetes, obesity, and cardiovascular disease. *Am J Clin Nutr*. 2013. doi: 10.3945/ajcn.113.067629.
86. Vajdi, M., & Farhangi, M. A. A systematic review of the association between dietary patterns and health-related quality of life. *Health Qual Life Outcomes*. 2020:18:337. doi: https://doi.org/10.1186/s12955-020-01581-z.
87. Margerison, C., Riddell, L., et al. Associations between dietary patterns and blood pressure in a sample of adult Australian adults. 2020. Available at https:nutrition.biomedcentral.com/articles/10.1186/s12937-019-2.
88. Schwingshackl, L., et al. Food groups and risk of all-cause mortality: A systematic review and meta-analysis of prospective studies. *Am J Clin Nutr*. 2017; 105:1462–1473.

Chapter 2

1. Louis, G. M. B., et al. Periconception window: Advising the pregnancy planning couple. *Fertil Steril*. 2008; 89(2 Suppl):e119–e121.
2. Stephenson, J., et al. Before the beginning: Nutrition and lifestyle in the preconception period and its importance for future health. *The Lancet*. 2018; 39(10132):1830–1842.
3. Kauffman, A. S., et al. Critical periods of susceptibility to short-term energy challenge during pregnancy: Impact on fertility and offspring development. *Physiol Behav*. 2010; 99:100–108.
4. Ramírez-Vélez, R. In utero fetal programming and its impact on health in adulthood. *Endocrinol Nutr*. 2012 Jun–Jul; 59(6):383–393. Available at www.ncbi.nlm.nih.gov/pubmed/22483564.
5. Fleming, T. P., et al. Origins of lifetime health around the time of conception: causes and consequences *The Lancet*. 2018; 391(10132):1842–1852.
6. Copen, A., et al. How common is infertility? National Institute of Child Health and Human Development. 2018 Feb. Available at https://www.nichd.nih.gov/health/topics/infertility/conditioninfo/common#:~:text=Studies%20suggest%20that%20after%201,had%20a%20live%2Dborn%20baby.&text=(In%20couples%20younger%20than%20age,3%20months%20of%20trying.5). Last accessed February 12, 2023.
7. Hamilton, B. E., et al. Vital Statistics Rapid Release Report No. 012 *v* May 2021 Births: Provisional Data for 2020 Division of Vital Statistics, National Center for Health Statistics. Available at https://www.cdc.gov/nchs/data/nvsr/nvsr70/nvsr70-02-508.pdf, accessed March 15, 2023.
8. Herbert, D. L., et al. Birth outcomes after spontaneous or assisted conception among infertile Australian women aged 28 to 36 years: A prospective, population-based study. *Fertil Steril*. 2012; 97:603–608.
9. Dunson, D. B. Increased infertility with age in men and women. *Obstet Gynecol*. 2004; 103:51–56.
10. Van Voorhis, B. J. *In vitro* fertilization. *N Engl J Med*. 2007; 356:379–386.
11. How to Get Pregnant. Best Tips to Help You Conceive. Available at https://www.americanpregnancy.org/getting-pregnant/how-to-get-pregnant/, accessed March 16, 2023.
12. Kovac, P. Recurrent pregnancy loss. Available at www.medscape.com/viewprogram/529862, accessed March 16, 2023.
13. What age-related factors may be involved with infertility in females and males? 2017 Jan. National Institute of Child Health and Human Development. Available at wwwnichd.nih.gov/health/topics/infertility, accessed February 12, 2023.
14. Fertility research brings death of dogma, birth of hope. *ScienceDaily*, September 16, 2017. Available at www.sciencedaily.com/releases/2017/09/170916080143.htm.
15. Gaskins, A. J., et al. Prepregnancy low to moderate alcohol intake in not associated with risk of spontaneous abortion or stillbirth. *J Nutr*. 2016; 146:799–805.
16. Das, L., et al. Epigenetics of reproductive infertility. *Front Biosci (Schol Ed)*. 2017; 9:509–535.
17. Chavarro, J. E., et al. Diet and lifestyle in the prevention of ovulatory disorder infertility. *Obstet Gynecol*. 2007; 110(5):1050–1058.
18. Wankhede, S., et al. Evaluation of cases of infertility by diagnostic laparoscopy. *Int J Reprod Contracept Obstet Gynecol*. 2017; 6. doi: dx.doi.org/10.18203/2320-1770.ijrcog20170557.
19. Habibi, N., et al. Is the Association between Age and Fertility Problems Modified by Diet Quality? Findings from a National Study of Reproductive Age Women in Australia. *Nutrients*. 2022 Oct 18; 14(20):4355. doi: 10.3390/nu14204355. PMID: 36297039; PMCID: PMC9606952.
20. Trent, M., et al. Adverse adolescent reproductive health outcomes after pelvic inflammatory disease. *Arch Pediatr Adolesc Med*. 2011; 165:49–54.
21. Giudice, L. C. Endometriosis. *N Engl J Med*. 2010; 362:2389–2398.
22. Edi, R., & Cheng, T. Endometriosis: Evaluation and treatment. *Am Fam Physician*. 2022 Oct; 106(4):397–404. PMID: 36260896.
23. Puscheck, E. E., et al. Infertility. November 2014. Available at emedicine.medscape.com/article/274143-overview?src=wnl_ref_clinfo&uac=61213SX, accessed February 13, 2015.
24. Gordon, C. M., et al. Functional hypothalamic amenorrhea: An Endocrine Society Clinical Practice Guideline. *Clin Endocrinol Metab*. 2017; 102:1413–1439.
25. Pesant, M.-H., et al. The lack of effect of insulin on luteinizing hormone pulsatility in healthy male volunteers provides evidence of a sexual dimorphism in the metabolic regulation of reproductive hormones. *Am J Clin Nutr*. 2012; 96:283–288.
26. Bongaarts, J. Does malnutrition affect fecundity? A summary of evidence. *Science*. 1980; 208:564–569.
27. Gordon, C. Ackerman, K., et al. Functional Hypothalaic Amenorrhea. Available at https://academic.oup.com/jcem/article/102/5/1413/300772 81. Published March 22, 2017.
28. Position of the American Dietetic Association: Obesity, reproduction, and pregnancy outcomes. *J Am Nutr Diet*. 2016; 116:667–691.
29. Practice Committee of the American Society for Reproductive Medicine. Electronic address: asrm@asrm.org; Practice Committee of the American Society for Reproductive Medicine. Obesity and reproduction: A committee opinion. *Fertil Steril*. 2021 Nov; 116(5):1266–1285. doi: 10.1016/j.fertnstert.2021.08.018. Epub 2021 Sep 25. PMID: 34583840.
30. Ramaraju, G. A., et al. Association between obesity and sperm quality. *Andrologia*. 2017; e12888. doi: doi.org/10.1111/and.12888.
31. Kozopas, N. M., et al. Body mass index and sperm quality: Is there a relationship? *J Hum Reprod Sci*. 2020 Apr–Jun; 13(2):110–113. doi: 10.4103/jhrs.JHRS_15_20. Epub 2020 Jul 9. PMID: 32792758; PMCID: PMC7394096.
32. State of Obesity 2022: Better Policies for a Healthier America. Available at https://www.tfha.org/reports-details/state-of-obestity-2022/, accessed March 17, 2023.
33. Reichlin, S. Female fertility and the body fat connection (review). *N Engl J Med*. 2003; 348:869–870.
34. U. S. Department of Health and Human Services: Office on Women's Health Underweight. Available at https://www.womenshealth.gov/healthy-weight/underweight, accessed March 17, 2023.
35. Bolúmar, F., et al. Body mass index and delayed conception: A European Multicenter Study on Infertility and Subfecundity. *Am J Epidemiol*. 2000; 151:1072–1079.
36. Keys, A., et al. *The Biology of Human Starvation*. Minneapolis, MN: University of Minnesota Press, 1950.
37. Lieberman, J., De Souza, M., et al. Menstrual disruption with exercise is not linked to an energy availability threshold. *Med Sci Sports Exerc*. 2018 Mar; 50(3): 551–561. doi 10.1249/MSS.0000000000001451, accessed February 12, 2023.

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References

38. Mulla, A. L., et al. Role of Antioxidants in Female Fertility. *Open J Obstet Gynecol*. 2018; 8:85–91. doi: https://doi.org/10.4236/ojog.2018.82011.
39. Ricci, E., et al. Dietary habits and semen parameters: A systematic narrative review. *Andrology*. 2017; 6:104–116.
40. Mendiola, J., et al. A low intake of antioxidant nutrients is associated with poor semen quality in patients attending fertility clinics. *Fertil Steril*. 2010; 93:1128–1133. doi: 10.1016/j.fertnstert.2008.10.075.
41. Eskenazi, B., et al. Antioxidant intake is associated with semen quality in healthy men. *Hum Reprod*. 2005; 20:1006–1012.
42. De Luca, M., Colone, M., et al. Oxidative stress and male fertility: Role of antioxidants and inositols. Available at Mdpi.com/2076-3921/10/8/1283. Published August 13, 2021.
43. Chavarro, J. E., et al. Diet and lifestyle in the prevention of ovulatory disorder infertility. *Obstet Gynecol*. 2007 Nov; 110(5):1050–1058. doi: 10.1097/01.AOG.0000287293.25465.e1. PMID: 17978119.
44. de Ligny, W., et al. Antioxidants for male subfertility. *Cochrane Database of Systematic Reviews 2022*, Issue 5. Art. No.: CD007411. doi: 10.1002/14651858.CD007411.pub5. Copyright © 2022 The Cochrane Collaboration. Published by John Wiley & Sons, Ltd.
45. Agarwal, A., et al. Utility of antioxidants during assisted reproductive techniques: An evidence based review. *Reprod Biol Endocrinol*. 2014; 12:112. doi: 10.1186/1477-7827-12-112.
46. Walczak–Jedrzejowska, R., et al. The role of oxidative stress and antioxidants in male fertility. *Cent European J Urol*. 2013; 66(1):60–67.
47. Tian, X., et al. Acute dietary zinc deficiency before conception compromises oocyte epigenetic programming and disrupts embryonic development. *Dev Biol*. 2013; 376(1):51–61.
48. Calderón, B., et al. Circulating Zinc and Copper Levels are Associated with Sperm Quality in Obese Men after Metabolic Surgery: A Pilot Study. *Nutrients*. 2020 Oct 30; 12(11):3354. doi: 10.3390/nu12113354. PMID: 33143218; PMCID: PMC7692370.
49. Zhao, J., Dong, X., et al. Zinc levels in seminal plasma and their correlation with male infertility. Available at https://www.nature.com/articles/srep22386. Published March 2, 2016.
50. Abbasi, A. A., et al. Experimental zinc deficiency in man. Effect on testicular function. *J Lab Clin Med*. 1980; 96:544–550.
51. Dietary Guidelines for Americans, 2020–2025. Available at https://www.dietaryguidelines.gov/resources/dietary-guidelines-2020-2025-online-materials, accessed March 20, 2023.
52. Second National Report on Biochemical Status Indicators of Diet and Nutrition in the U.S. Population. CDC, National Center for Environmental Health, Division of Laboratory Sciences, March 27, 2012. Available at www.cdc.gov/nutritionreport, accessed March 20, 2023.
53. Healthy People 2030. Available at https://health.gov/healthypeople/objectives-and-data/browse-objectives/nutrition-and-healthy-eating/reduce-iron-deficiency-females-aged-12-49-years-nws-17/data-methodology, accessed March 21, 2023.
54. Chavarro, J. E., et al. Iron consumption and the risk of infertility. *Obstet Gynecol*. 2006; 108:1145–1152.
55. Steinmetz, E. K. The effect of caffeine on fecundability: Differences in coffee, tea, and cola consumption. Electronic theses and dissertations. 2017. Paper 2694. doi: doi.org/10.18297/etd/2694.
56. Lynoso, J., et al. Association between coffee or caffeine consumption and fecundity and fertility: A systematic review and dose–response meta-analysis. *Clin Epidemiol*. 2017; 9:699–719.
57. Bolumar, F., et al. Caffeine intake and delayed conception: A European multicenter study on infertility and subfecundity. European study group on infertility subfecundity. *Am J Epidemiol*. 1997; 145:324–334.
58. Gaskins, A. J., et al. Prepregnancy low to moderate alcohol intake is not associated with risk of spontaneous abortion or stillbirth. *J Nutr*. 2016; 146:799–805.
59. Muggli, M., et al. Association between prenatal alcohol exposure and craniofacial shape of children at 12 months of age. *JAMA Pediatr*. Published online June 5, 2017. doi: 10.1001/jamapediatrics.2017.0778.
60. Topiwala, A., et al. Moderate alcohol consumption as risk factor for adverse brain outcomes and cognitive decline: Longitudinal cohort study. *BMJ*. 2017; 357:j2353.
61. Leon, O., and Pacheco, J. Effects of lead on reproductive health. Published April 15, 2020. Available at https://www.intechopen.com/chapters/71715.
62. Lamb, E. J., et al. Epidemiologic studies of male factors in infertility. *Ann NY Acad Sci*. 1994; 709:165–178.
63. Queiroz, E. K., et al. Occupational exposure and effects on the male reproductive system. *Cad Saude Publica*. 2006; 22:485–493.
64. Sengupta, P. Environmental and occupational exposure of metals and their role in male reproductive functions. 2012: 353–368. doi: https://doi.org/10.3109/01480545.2012.710631.
65. Wirth, J. J., et al. Adverse effects of low level heavy metal exposure on male reproductive function. *Syst Biol Reprod Med*. 2010; 56:147–167.
66. Meeker, J. D., et al. Cadmium, lead, and other metals in relation to semen quality: Human evidence for molybdenum as a male reproductive toxicant. *Environ Health Perspect*. 2008; 116:1473–1479.
67. Queiroz, E. K., et al. Occupational exposure and effects on the male reproductive system. *Cad Saude Publica*. 2006; 22:485–493.
68. Kishner, S., et al. Low Energy Availability in Female Athletes. 2021 Nov 12. Available at https://www.emedicine.medscape.com/article 312312, accessed March 21, 2023.
69. Loucks, A. B., et al. The female athlete triad: Do female athletes need to take special care to avoid low energy availability? *Med Sci Sports Exerc*. 2006; 38:1694–1700.
70. Soleimany, G., et al. Bone mineral changes and cardiovascular effects among female athletes with chronic menstrual dysfunction. *Asian J Sports Med*. 2012; 3:53–58.
71. Mursu, J., et al. Dietary intake, serum hormone concentrations, amenorrhea and bone mineral density of physique athletes and active gym enthusiasts. *Nutrients*. 2023 Jan 12; 15(2):382. doi: 10.3390/nu15020382. PMID: 36678253; PMCID: PMC9862069.
72. Lassi, Z. S., et al. Preconception care: Caffeine, smoking, alcohol, drugs, and other environmental chemical/radiation exposure. *Reprod Health*. 2014 Sep 26; 11 Suppl 3(Suppl 3):S6. doi: 10.1186/1742-4755-11-S3-S6. Epub 2014 Sep 26. PMID: 25415846; PMCID: PMC4196566.
73. Kim, M. H., et al. Factors associated with a positive intake of folic acid in the periconceptional period among Korean women. *Public Health Nutr*. 2009; 12(4):468.
74. Position of the Academy of Nutrition and Dietetics: Nutrition and lifestyle for a healthy pregnancy outcome. *J Acad Nutr Diet*. 2014; 114:1099–1103.
75. Langley-Evans, S. C. Nutrition in early life and the programming of adult disease. *J Human Nutr Diet*. January 28, 2015. doi: 10.1111/jhn.12212.
76. Occurrence prevention, December 2014. Available at www.cdc.gov/ncbddd/folicacid/recommendations.html, accessed March 21, 2023.
77. Greenberg, J. A., et al. Folic acid supplementation and pregnancy: More than just neural tube defect prevention. *Rev Obstet Gynecol*. 2011; 4:52–59.
78. Williams, J., et al. Updated estimates of neural tube defects prevented by mandatory folic acid fortification—United States, 1995–2011. *MMRWeekly*, 2015; 64(01):1–5. Available at www.cdc.gov/mmwr/preview/mmwrhtml/mm6401a2.htm, accessed March 2023.
79. Dunlap, B., et al. Folic acid and human reproduction—Ten important issues for clinicians. *J Exp Clin Assist Reprod*. 2011; 8:2. Published online August 10, 2011. Available at www.ncbi.nlm.nih.gov/pmc/articles/PMC3183498/?tool=pmcentrez.
80. Poretti, A., et al. Neural tube defects in Switzerland from 2001 to 2007: Are periconceptual folic acid recommendations being followed? *Swiss Med Wkly*. 2008; 138:608–613.
81. Chen, L. W., et al. Maternal folate status, but not that of vitamins B_{12} or B_6, is associated with gestational age and preterm birth

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References

risk in a multiethnic Asian population. *J Nutr.* January 2015; 145(1):113–120. doi: 10.3945/jn.114.196352.

82. Hodgetts, V. A., et al. Effectiveness of folic acid supplementation in pregnancy on reducing the risk of small-for-gestational age neonates: A population study, systematic review and meta-analysis. *BJOG*. 2015; 122(4):478–490. doi: 10.1111/1471-0528.13202. Published online November 26, 2014.
83. Nutrient Intakes from Food and Beverages: Mean Amounts Consumed per Individual, by Gender and Age, What We Eat in America, NHANES 2017–2018. Agricultural Research Service. 2018. Available at www.ars.usda.gov/ARSUUserFiles/Place/80400530/pdf/1718/Table_1_NIN_GEN_17.pdf, accessed March 21, 2023.
84. Folic Acid. Available at https://www.cdc.gov/ncbddd/folicacid/index.html, accessed May 16, 2023.
85. USDA Nutrient Data Bank. Available at https:// fdc.nal.usda.gov/fdc-app.html#/food-details/174924/nutrients.
86. Greenberg, J. A., et al. Folic acid supplementation and pregnancy: More than just neural tube defect prevention. *Rev Obstet Gynecol*. 2011; 4:52–59.
87. Crider, K. S., Yang, T. P., et al. MTHER Gene, Folic Acid and Preventing Neural Tube Defects. Available at https://www.cdc.gov/ncbddd/folicacid/mthfr-gene-and-folic-acid-html. Last reviewed July 6, 2020.
88. Anderson, P. Less than half of young women with epilepsy take folic acid. December 2013. Available at www.medscape.com/viewarticle/ 817559, accessed May 3, 2015.
89. Arth, A, et al. Supplement use and other characteristics among pregnant women with a previous pregnancy affected by a neural tube defect—United States, 1997–2009. *Weekly*. January 16, 2015; 64(01);6–9. Available at www.cdc.gov/mmwr/preview/mmwrhtml/mm6401a3.htm?s_cid=mm6401a3_w.
90. Dunlap, B., et al. Folic acid and human reproduction—Ten important issues for clinicians. *J Exp Clin Assist Reprod*. 2011; 8:2. [published online]. Available at www.ncbi.nlm.nih.gov/pmc/articles/PMC3183498/?tool=pmcentrez.
91. Hamner, H. C., et al. Fortification of corn masa flour with folic acid in the United States: An overview of the evidence. *Ann N Y Acad Sci*. 2014; 1312:8–14.
92. FDA approves folic acid fortification of corn masa flour. Available at www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm496104.htm, accessed April 14, 2016.
93. West, A. S., et al. Folate-status response to a controlled folate intake in nonpregnant, pregnant, and lactating women. *Am J Clin Nutr*. 2012; 96:789–800.
94. Micronutrient. Available at www.cdc/nutrition/micronutrient-malnutrition/index.html/, accessed March 21, 2023.
95. Allen, L. H. Biological mechanisms that might underlie iron's effects on fetal growth and preterm birth. *J Nutr*. 2001; 131:581S–589S.
96. Kabir, M. A., Rahman, M. M., & Khan, M. N. Maternal anemia and risk of adverse maternal health and birth outcomes in Bangladesh: A nationwide population-based survey. *PLoS One*. 2022 Dec 16; 17(12):e0277654. doi: 10.1371/journal.pone.0277654. PMID: 36525409; PMCID: PMC9757595.
97. Vandevijvere, S., et al. Iron status and its determinants in a nationally representative sample of pregnant women. *J Acad Nutr Diet*. 2013; 113:659–666.
98. *Dietary Reference Intakes for Vitamin A through Zinc, Food and Nutrition Board, Institute of Medicine*. Washington, DC: National Academy Press, 2001.
99. Dietary Reference Intakes. Food and Nutrition Board, Institute of Medicine, National Academy of Sciences. Available at www.nap.edu, accessed March 21, 2023.
100. Gardiner, P. M., et al. The clinical content of preconception care: Nutrition and dietary supplements. *Am J Obstet Gynecol*. December 2008. doi: 10.1016/j.ajog.2008.10.049.
101. Khan, N. N., Boyle, J. A., Lang, A.Y., & Harrison, C. L. Preconception health attitudes and behaviours of women: A qualitative investigation. *Nutrients*. 2019; 11(7):1490. doi: https://doi.org/10.3390/nu11071490.
102. 2020 Dietary Guidelines Advisory Committee. Advisory report to the Secretary of Health and Human Services and Secretary of Agriculture. Published June 30, 2020. Available at http://www.health.gov/dietaryguidelines/2015-scientific-report/PDFs/Scientific-Report-of-the-2015Dietary-Guidelines-Advisory-Committee.pdf, accessed March 21, 2023.
103. Grieger, J. A., et al. Preconception dietary patterns in human pregnancies are associated with preterm delivery. *J Nutr*. 2014; 144:1075–1080.
104. Gardiner, P. M., et al. The clinical content of preconception care: Nutrition and dietary supplements. *Am J Obstet Gynecol*. 2008 Dec; 199(6 Suppl 2):S345–S356. doi: 10.1016/j.ajog.2008.10.049.
105. Curtis, K. M., et al. Long-acting reversible contraception. *N Engl J Med*. 2017; 376:461–469.
106. Sitruk-Ware, R. Which hormonal contraceptives lower thrombosis risk? *Fertit Steril*. 2016; 106:1289–1294.
107. Agren, U. M., et al. Effects of a monophasic combined oral contraceptive containing nomegestrol acetate and 17β-oestradiol compared with one containing levonorgestrel and ethinylestradiol on haemostasis, lipids and carbohydrate metabolism. *Eur J Contracept Reprod Health Care*. 2011; 16:444–457.
108. Winner, B., et al. Effectiveness of long-acting reversible contraception. *N Engl J Med*. 2012; 366:1998–1908.
109. Effect of birth control pills and patches on weight, January 2014. Available at www.cochrane.org/CD003987/FERTILREG_effect-of-birth control-pills-and-patches-on-weight, accessed April 30, 2015.
110. Caldwell, A., & Zaman, A. Impact of combined hormonal contraceptive use on weight loss. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7556729/. Published June 28, 2020.
111. Lopez, L. M., et al. Progestin-only contraceptives: Effects on weight. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5034734/. Published August 28, 2016.
112. Wiegratz, I., et al. Hormonal contraception—What kind, when, and for whom? *Dtsch Arztebl Int*. 2011; 108(28–29):495–506.
113. Lidegaard, O., et al. Thrombotic stroke and myocardial infarction with hormonal contraception. *N Engl J Med*. 2012; 366:2257–2266.
114. Berenson, A. B., et al. Effect of injectable and oral contraceptives on glucose and insulin levels. *Obstet Gynecol*. 2011; 117:41–47.
115. Chao, J. H., et al. The current state of male hormonal contraception. *Pharmacol Therapautics*. 2016; 163:109–117.
116. WIC Eligibility Requirements. Food and Nutrition Services. Available at www.fns.usda.gov/wic/wic-eligibility-requirements, accessed February 12, 2023.
117. The Role of the WIC Program in Improving Periconceptional Nutrition: A Small-Grants Research Program. Available at www.ph.ucla.edu. Accessed February 12, 2023.
118. Nazli, B., et al. About WIC: How it works. Published October 10, 2013. Available at https://www.fns.usda.gov/wic/about-wic-how-wic-helps, accessed February 12, 2023.
119. Jus'at, I., et al. Reaching young Indonesian women through marriage registries: An innovative approach for anemia control. *J Nutr*. 2000; 130:456S–458S.
120. Nguyen, P. H., et al. Preconception micronutrient supplementation with iron and folic acid alone affects linear growth and fine motor development at 2 years of age: A randomized controlled trial in Vietman. *J Nutr*. 2017; 147:1593–1601.
121. Ramakrishnan, U., et al. Effect of women's nutrition before and during early pregnancy on maternal and infant outcomes: A systematic review. *Paediatr Perinat Epidemiol*. 2012; 26(Suppl 1):285–301.
122. Before Pregnancy. CDC, December 2017. Available at www.cdc.gov/preconception/index.html. Accessed February 12, 2023.
123. *Summary of the Nutrition Care Process Steps for Nutrition Assessment (Pocket Guide for International Dietetics & Nutrition Terminology*), Reference Manual, 2nd ed. Chicago, IL: American Dietetic Association, 2009.
124. The Academy Quality Management Commit- tee. AND: Revised 2017 standards of practice in nutrition care and standards of professional performance for registered dietitians. *Am Acad Nutr Diet*. 2018; 118:132–140.

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References

Chapter 3

1. Roberts, J. M., et al. Global Pregnancy Collaboration symposium: Prepregnancy and very early pregnancy antecedents of adverse pregnancy outcomes: Overview and recommendations. *Placenta*. 2017; 60:103–109.
2. Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med*. 2002; 346:393–403.
3. Mijatovic-Vukas J., et. al. Associations of diet and physical activity with risk for gestational diabetes mellitus: A systematic review and meta-analysis. *Nutrients*. 2018; 10(6):698. doi: https://doi.org/10.3390/nu10060698.
4. Fryar, C. D., Carroll, M. D., & Afful, J. Prevalence of underweight among adults aged 20 and over: United States, 1960–1962 through 2017–2018. NCHS Health E-Stats. 2020. Available at www.cdc.gov/nchs/data/hestat/underweight_adult_17_18/underweight_adult_17_18.htm, accessed March 24, 2023.
5. Overweight & obesity statistics. Available at www.niddk.nih.gov/health-information/health-statistics/overweight-obesity, accessed March 24, 2023.
6. Ismali, E., et al. Fourth consensus of the International Society for Premenstrual Disorders (ISPMD): Auditable standards for diagnosis and management of premenstrual disorder. *Arch Women Mental Health*. 2016; 19:953–958.
7. Wyatt, K. M., et al. Efficacy of vitamin B-6 in the treatment of premenstrual syndrome: Systematic review. *BMJ*. 318; 1999:1375–1381.
8. Silvestris, E., Pergola, G., et al. Obesity as disruptor of the female fertility. https://rbej.biomedcentral.com/articles/10.1186/s12958-018-0336-z. Published March 9, 2018.
9. Lopez-Garcia, E., et al. Metabolically healthy obesity and health-related quality of life: A prospective cohort study. *Clin Nutr*. 2017; 36:853–860.
10. Pasquali, R., et al. Metabolic effects of obesity on reproduction. *Reprod Biomed Online*. 2006; 12:542–551.
11. Martins, A., Majzoub A. Metabolic syndrome and male fertility. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6479081/ Published online October 22, 2018.
12. Chavarro, J. E., et al. Body mass index in relation to semen quality, sperm DNA integrity and serum reproductive hormone levels among men attending an infertility clinic. *Fertil Steril*. 2010; 93:2222–2231.
13. Jia, Y. F., Feng, Q., Ge, Z. Y., et al. Obesity impairs male fertility through long-term effects on spermatogenesis. *BMC Urol*. 2018; 18:42. doi: https://doi.org/10.1186/s12894-018-0360-5.
14. MaRoth, M. Y., et al. Treatment of male infertility secondary to morbid obesity. Nat *Clin Pract Endocrinol Metab*. 2008; 4:415–419.
15. Suren, P., et al. Parental obesity and risk of autism spectrum disorder. *Pediatrics*. doi: 10.1542/peds.2013-3664. Published online April 7, 2014
16. Li, Y. M., Ou, J. J., Liu, L., et al. Association between maternal obesity and autism spectrum disorder in offspring: A meta-analysis. *J Autism Dev Disord*. 2016; 46:95–102. doi: https://doi.org/10.1007/s10803-015-2549-8.
17. O'Connor, L., et al. Intakes and sources of dietary sugars and their association with metabolic and inflammatory markers. *Clin Nutr*. May 2017. doi: doi.org/10.1016/j.clnu.2017.05.030.
18. Travers, R. L., et al. The impact of adiposity on adipose tissue-resident lymphocyte activation in humans. *Int J Obes*. 2015; 39:762–769.
19. Kauffman, A. S., et al. Critical periods of susceptibility to short-term energy challenge during pregnancy: Impact on fertility and offspring development. *Physiol Behav*. 2010; 99:100–108.
20. Metabolic Syndrome. Mayo Clinic. Patient Care and Health Information: Diseases and Conditions. May 6, 2021. Available at https://www.mayoclinic.org/diseases -conditions/metabolic-syndrome/diagnosis-treatment/dr-20351921, accessed March 24, 2023.
21. Hirode, G., & Wong, R. J. Trends in the prevalence of metabolic syndrome in the United States, 2011–2016. *JAMA*. 2020; 323(24):2526–2528. doi: 10.1001/jama.2020.4501. PMID: 32573660; PMCID: PMC7312413.
22. Normandin, E., et al. Effect of resistance training and caloric restriction on the metabolic syndrome. *Med Sci Sports Exer*. 2017; 49:413–419.
23. Alberti, K. G., et al. Harmonizing the metabolic syndrome. A joint statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and the International Association for the Study of Obesity. *Circulation*. 2009; 120:1640–1645.
24. Riediger, N. D., et al. Prevalence of metabolic syndrome in the Canadian adult population. *CMAJ*. 2011; 183:e1127–e1134.
25. Metabolic syndrome: A health crisis hiding in plain sight. Available at https://metaboicsyndromecanada.ca/about-metabolic-syndrome, accessed March 24, 2023.
26. Azadbakht, L., et al. Beneficial effects of a Dietary Approaches to Stop Hypertension Eating Plan on Features of the Metabolic Syndrome. Available at https://academic.oup.com/jn/article/141/6/1083/4600275. Published April 27, 2011.
27. Castro-Barquero, S. Dietary strategies for metabolic syndrome: A comprehensive review. *Nutrients*. 2020; 12(10):2983. doi: https://doi.org/10.3390/nu12102983.
28. Das, S. K., et al. Adipose tissue gene expression and metabolic health of obese adults. *Int J Obes*. 2015; 39:869–873.
29. Araújo, J., Cai, J., & Stevens, J. Prevalence of optimal metabolic health in American adults: National health and nutrition examination survey 2009–2016. *Metabol Synd Rel Dis*. 2019; 17(1):46–52.
30. Serralde-Zúñiga, A. E., et al. Omental adipose tissue gene expression, gene variants, branched-chain amino acids, and their relationship with metabolic syndrome and insulin resistance in humans. *Genes Nutr*. 2014; 9:431. doi: 10.1007/s12263-014-0431-5.
31. Silvestris, E. et al. Obesity as a disruptor of the female fertility. Available at https://rbej.biomedcentral.com/articles/10.1186/s12958-018-0336-z. Published March 9, 2018.
32. Tzoulaki L., et al. Being Overweight or obese is linked with heart disease even without other metabolic risk factors. Available at https://evidence.nihr.ac.uk/alert/being-overweight-or-obese-is-linked-with-heart-disease-even-without-other-metabolic-risk-factors/. Published on November 7, 2017.
33. Physical activity and health, February 2011. Available at www.cdc.gov/physicalactivity/everyone/health/index.html?s_cid=tw_ob279. Reviewed November 1, 2021.
34. Johnson, D. A. Tips for monitoring post-bariatric surgery nutritional deficiency, February 14, 2017. Available at www.medscape.com/viewarticle/875462?nlid=112987_434&src=WNL_mdplsfeat_170221_mscpedit_diab&uac=61213SX&spon=22&impID=1294763&faf=1.
35. Vaughan, E., et al. Weight loss versus behavioral change as the primary goal in clinical practice. *Am J Lifestyle Med*. 2015. doi: 10.1177/1559827615579166.
36. Akhter, Z., et al. Pregnancy after bariatric surgery and adverse perinatal outcomes. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6684044/. Published online August 6, 2019.
37. The Practice Committee of the American Society for Reproductive Medicine, Obesity and Reproduction. *Fertil Steril*. 2015 Nov; 104(5):1116–1126. doi: 10.1016/j.fertnstert.2015.08.018. Available at https://pubmed.ncbi.nlm.nih.gov/26434804/.
38. Hazart, J., et al. Maternal nutritional deficiencies and small-for-gestational-age neonates at birth of women who have undergone bariatric surgery. *J Pregnancy*. 2017. doi: doi.org/10.1155/2017/4168541.
39. Willis, K., et al. Bariatric surgery and pregnancy outcome—The ultimate solution? *Am J Obstet Gynecol* 2014. doi: 10.1016/j.bpobgyn.2014.04.015.
40. The Practice Committee of the American Society for Reproductive Medicine, Obesity and Reproduction: An educational bulletin. *Fertil Steril*. 2015; 90:S21–S29.
41. Gordon, C. M. Functional hypothalamic amenorrhea. Available at https://academic.oup.com/jcem/article/102/5/1413/3077281. Published March 22, 2017.
42. Kauffman, A. S., et al. Critical periods of susceptibility to short-term energy challenge during pregnancy: Impact on fertility and offspring development. *Physiol Behav*. 2010; 99:100–108.

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References

43. Haines, M. S. Endocrine complications of anorexia nervosa. *J Eat Disord*. 2023; 11:24. doi: https://doi.org/10.1186/s40337-023-00744-9.
44. Poterasu, M., et al. Anorexia nervosa and reproduction: Connecting brain to gonads. *J Mind Med Sci*. 2020; 7(1): Article 2. doi: https://doi.org/10.22543/7674.71.P18. Available at https://scholar.valpo.edu/jmms/vol7/iss1/2, accessed March 24, 2023.
45. Good Health Before Pregnancy: Preconception Care. ACOG 2017. Available at www.acog.org/Patients/FAQs/Good-Health-Before-Pregnancy-Preconception-Care.
46. Wasserfurth, P., Palmowski, J., et al. Reason for Consequences of low energy availability in female and male athletes. Published online September 10, 2020. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7483688/-overview, accessed January 16, 2014.
47. Maxwell, M., et al. Life beyond the eating disorder: Education, relationships, and reproduction. *Int J Eat Disord*. 2011; 44:225–232.
48. Soleimany, G., et al. Bone mineral changes and cardiovascular effects among female athletes with chronic menstrual dysfunction. *Asian J Sports Med*. 2012; 3:53–58.
49. Wise L. A., et al. Body size and time-to-pregnancy in black women. *Hum Reprod*. 2013; 28:2856–2864.
50. Boggs W. Military Physical Training Alters Peptides, Menstruation in Women. June 22, 2017. Available at www.medscape.com/viewarticle/881897?nlid=115994_2042&src=WNL_mdplsnews_170623_mscpedit_obgy&uac=61213SX&spon=16&impID=1374548 &faf=1.
51. Thein-Nissenbaum, J., & Hammer, E. Treatment strategies for the female athlete triad in the adolescent athlete: Current perspectives. *Open Access J Sports Med*. 2017; 8:85–95. doi: 10.2147/OAJSM.S100026.
52. Pietrangelo, A. What are the different types of diabetes? Updated May 9, 2022. Available at http://www.healthline.com/health/diabetes/types-of-diabetes, accessed March 24, 2023.
53. Diabetes Statistics. National Institute of Diabetes and Digestive and Kidney Diseases. February 2023. Available at https://www.niddk.nih.gov/health-information/health-statistics/diabetes-statistics, accessed March 25, 2023.
54. Magdaleno, A., et al. Preconception Counseling In Women With Diabetes By Primary Care Providers And Perceived Barriers To Initiating This Discussion. *Endocr Pract*. 2020 Feb; 26(2):226–234. doi: 10.4158/EP-2019-0256.
55. Carr, S. R. Effect of maternal hyperglycemia on fetal development. American Dietetic Association Annual Meeting and exhibition, Kansas City, MO, October 10, 1998.
56. Zhang, C., Rawal, S., & Chong, Y. S. Risk factors for gestational diabetes: Is prevention possible? *Diabetologia*. 2016; 59:1385–1390. doi: https://doi.org/10.1007/s00125-016-3979-3,
57. American Diabetes Association. Glycemic targets. *Diabetes Care*. 2017; 40(Suppl 1): S48–S56.
58. DeSisto, C. L., et al. Prevalence estimates of gestational diabetes mellitus in the United States, Pregnancy Risk Assessment Monitoring System (PRAMS), 2007–2010. *Prev Chronic Dis*. 2014. Available at www.cdc.gov/pcd/issues/2014/13_0415.htm.
59. Lemieux, I. Reversing type 2 diabetes: The time for lifestyle medicine has come! *Nutrients*. 2020; 12(7):1974. doi: https://doi.org/10.3390/nu12071974.
60. National Diabetes Statistics Report, 2017. Centers for Disease Control and Prevention.
61. Schenk, S., et al. Insulin sensitivity: Modulation by nutrients and inflammation. *J Clin Invest*. 2008; 118:2992–3002.
62. Ornoy, A., Becker, M., Weinstein-Fudim, L., & Ergaz, Z. Diabetes during pregnancy: A maternal disease complicating the course of pregnancy with long-term deleterious effects on the offspring. A clinical review. *Int J Mol Sci*. 2021; 22(6):2965. doi: https://doi.org/10.3390/ijms22062965.
63. National and State Diabetes Trends. May 17, 2022. Available at https://www.cdc.gov/diabetes/library/reports/reportcard/national-state-diabetes-trends.html, accessed March 25, 2023.
64. Nuha A., et al. On behalf of the American Diabetes Association, 5. Facilitating Positive Health Behaviors and Well-being to Improve Health Outcomes. *Standards of Care in Diabetes—2023. Diabetes Care*. 2023 Jan 1; 46(Suppl 1):S68–S96. doi: https://doi.org/10.2337/dc23-S005.
65. Kapadia, M. Z., et al. Weight loss instead of weight gain within the guidelines in obese women during pregnancy: A systematic review and meta-analysis of maternal and infant outcomes. *PLoS One*. July 21, 2015. doi: https://doi.org/10.1371/journal.pone.0132650, accessed March 25, 2023.
66. Tieu, J., Shepherd, E., Middleton, P., & Crowther, C. A. Dietary advice interventions in pregnancy for preventing gestational diabetes mellitus. *Cochrane Data Syst Rev*. 2017; Issue 1. Art. No.: CD006674. doi: 10.1002/14651858.CD006674.pub3, accessed March 26, 2023.
67. MacLeod, J. M., et al. Academy of Nutrition and Dietetics Nutrition Practice Guideline for type 1 and type 2 diabetes in adults: Nutrition intervention evidence reviews and recommendations. *Am J Nutr Diet*. 2017; 107:1637–1658.
68. Tobias, D. K., et al. Prepregnancy adherence to dietary patterns and lower risk of gestational diabetes mellitus. *Am J Clin Nutr*. 2012; 96:289–295.
69. Institute of Medicine, National Academy of Sciences. *Weight Gain During Pregnancy: Re-examining the Guidelines*. Washington, DC: National Academies Press, 2009.
70. Standards of Medical Care in Diabetes—2015 Abridged for Primary Care Providers, American Diabetes Association. Available at clinical.diabetesjournals.org/content/33/2/97.full.pdf.
71. Psaltopoulou, T., et al. The role of diet and lifestyle in primary, secondary, and tertiary diabetes prevention: A review of metaanalyses. *Rev Diabet Stud*. 2010; 7:26–35.
72. Lentschier, J. A., et. al. Polycystic ovarian syndrome and fertility. *Clin Obstet Gynecol*. 2021 Mar; 64(1):65–75. doi: 10.1097/GRF.0000000000000595.
73. Hultin, G. What to know about polycystic ovary syndrome. Food Nutr Mag. 2021 August; 10(4). Available at www.foodandnutrition.org, accessed December 2021.
74. MacReady, N. New PMD guidelines emphasizes multidisciplinary approach. 2016. *Medscape*. Available at https://www.medscape.com/viewarticle/872657.
75. Deputy, N. P., et al. Prevalence and trends in prepregnancy normal weight—48 states, New York City, and District of Columbia, 2011–2015. *Weekly*. 2018 Jan 5; 66(51):1402–1407.
76. McCartney, C. R., et al. Polycystic ovary syndrome. *NEJM*. 2016; 375:54–64.
77. Zore, T., et al. Polycystic ovarian syndrome: Long-term health consequences. *Semin Reprod Med*. 2017; 35:271–281.
78. Polycystic ovary syndrome, February 2014. Available at www.nlm.nih.gov/medlineplus/ency/article/000369.htm, accessed May 9, 2015.
79. O'Connor, L., et al. Prospective associations and population impact of sweet beverage intake and type 2 diabetes, and effects of substitutions with alternative beverages. *Diabetologia*. 2015. doi: 10.1007/s00125-015-3572-1.
80. Saleem, F., et al. New therapeutic approaches in obesity and metabolic syndrome associated with polycystic ovary syndrome. *Cureus*. November 2017; 9(11):e1844.
81. Nieuwenhuis-Ruifrok, A. E., et al. Insulin-sensitizing drugs for weight loss in women of reproductive age who are overweight or obese: Systematic review and meta-analysis. *Human Reprod Update*. 2009; 15:57–68.
82. van Spronsen, F. J., Blau, N., & Harding, C. et al. Phenylketonuria. *Nat Rev Dis Primers*. 2021; 7:36. doi: https://doi.org/10.1038/s41572-021-00267-0.
83. Giovannini, M., et al. Phenylketonuria: Nutritional advances and challenges. *Nutr Metab (Lond)*. 2012; 9:7. Published online February 3, 2012. doi: 10.1186/1743-7075-9-7.
84. Arnold, G. L., et al. Phenylketonuria treatment and management. 2014. Available at emedicine.medscape.com/article/947781-treatment.
85. Koch, R., Trefz, F., & Waisbren, S. Psychosocial issues and outcomes in maternal PKU. *Mol Genet Metab*. 2010; 99: suppl:S68–S74. doi: https://doi.org/10.1016/j.ymgme.2009.10.014.

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References

86. MacDonald, A., Wegberg, A., et al. PKU dietary handbook to accompany PKU guidelines. Available at https://ojrd.biomedcentral.com/articles/10.1186/s13023-020-01391-y. Published August 4, 2020.
87. Friedman, E. G., et al. The International Collaborative Study on maternal phenylketonuria: Organization, study design and description of the sample. *Eur J Pediatr.* 1996; 155(Suppl)1:S158–S161.
88. Trahms, C. M., et al. Program for Phenylketonuria: The Essentials of PKU. 2015. Available at depts.washington.edu/pku/resources/essentials.html.
89. Margaret, D. Available at www.savebabies.org/familystories/photos/MargaretDollPKU.jpg, accessed July 2009.
90. Simon, E., et al. Evaluation of quality of life and description of the sociodemographic state in adolescent and young adult patients with phenylketonuria (PKU). *Health Qual Life Outcomes.* 2008; 6:25.
91. Waisbren, S. E., et al. Outcome at age 4 years in offspring of women with maternal phenylketonuria: The Maternal PKU Collaborative Study. *JAMA.* 2000; 283:756–762.
92. Arnold, G. L., et al. Phenylketonuria treatment & management. *Medscape.* April 2014. Available at emedicine.medscape.com/article/947781-treatment, accessed April 28, 2015.
93. Maternal Phenylketonuria. Committee on Genetics. *Pediatrics.* 2008; 122(2):445–449. doi: https://doi.org/10.1542/peds.2008-1485.
94. Prick, B. W., et al. Maternal phenylketonuria and hyperphenylalaninemia in pregnancy: Pregnancy complications and neonatal sequelae in untreated pregnancies. *Am J Clin Nutr.* 2012; 95:374–382.
95. National PKU News. Available at https://www.rarediseases.org/organizations/national-pku-news, accessed March 26, 2023,
96. Glimberg, I., et al. The prevalence of celiac disease in women with infertility—A systematic review with meta-analysis. *Reprod Med Biol.* 2021 Mar; 20:2;224–233. doi: https://doi.org/10.1002/rmb2.12374.
97. Rapaport, L. Celiac disease linked to miscarriages and preterm deliveries, *Ann Gastroenterol.* 2015. Available at www.medscape.com/viewarticle/843296?nlid=80164_2826&src=wnl_edit_medn_fmed&uac=61213SX&spon=34, accessed May 6, 2015.
98. Stazi, A. V., et al. Reproductive aspects of celiac disease. *Ann Ital Med Int* 2005; 20:143–157.
99. Hadziselimovic, F., et al. Celiac disease, pregnancy, small for gestational age: Role of extravillous trophoblast. *Fetal Pediatr Pathol.* 2007; 26:125–134.
100. Gluten-free labeling of foods. March 7, 2022. Food and Drug Administration. Available at https://www.fda.gov/food/food-labeling-nutrition/gluten-free-labeling-foods, accessed March 25, 2023.
101. FDA sampling finds high level of compliance with gluten-free standards. May 30, 2017. Available at www.fda.gov/Food/NewsEvents/ConstituentUpdates/ucm560874.htm, accessed March 25, 2023.
102. Carey, M. Dilution of rice with other gluten free grains to lower inorganic arsenic in foods for young children in response to European Union regulations provides impetus to setting stricter standards. *PLoS One.* 2018 Mar 16; 13(3):e0194700. doi: 10.1371/journal.pone.0194700. PMID: 29547635; PMCID: PMC5856424.
103. American Nutrition and Dietetics Evidence-Analysis Library, Celiac. Available at https://www.andeal.org/topic.cfm?menu5279, accessed March 26, 2023.
104. Neumann, J. Celiac disease showing up in many forms and at all ages. December 1, 2014. Available at www.medscape.com/viewarticle/835567?src=wnl_edit_medn_wir&uac=61213SX&spon=34.
105. Kelly, C. P., et al. Advances in diagnosis and management of celiac disease. *Gastroenterology.* 2015; 148(6):1175–1186. doi: https://doi.org/10.1053/j.gastro.2015.01.044.
106. Rubio-Tapia, A., Hill, I. D., et al. Celiac disease tests. Available at https://www.niddk.nih.gov/health-information/professionals/clinical-tools-patient-management/digestive-diseases/celiac-disease-health-care-professionals. Last reviewed February 2021.
107. Rashtak, S., et al. Review article: Coeliac disease, new approaches to therapy. *Alimentary Pharmacol Therap.* 2012; 35(7):768–781.
108. Choi, J. M., et al. Increased prevalence of celiac disease in patients with unexplained infertility in the United States: A prospective study. *J Reprod Med.* May–June 2011; 56(5–6):199–203.
109. Rosenbaum, J. T. Celiac disease autoimmunity—The missing link. *NEJM.* 2017; 377:1489–1490.
110. Leonard, M. M., et al. Celiac disease and nonceliac gluten sensitivity: A review. *JAMA.* 2017; 318:647–656. doi: 10.1001/jama.2017.9730.
111. Lehman, L. More evidence for rise, and race difference, in U.S. celiac disease. *Reuters.* March 19, 2015. Available at www.reuters.com/article/2015/03/18/us-health-race-celiac-gluten-idUSKBN0ME2SY20150318, accessed March 13, 2015.
112. Mansueto, P., et al. Non-celiac gluten sensitivity: Literature review. *J Am Coll Nutr.* 2014; 33:39–54.
113. Igbinedion, S. O., et al. Non-celiac gluten sensitivity: All wheat attack is not celiac. *World J Gastroenterol.* 2017; 23:7201–7210.
114. Lebwhol, B., et al. Long-term gluten consumption in adults without celiac disease and risk of coronary heart disease: Prospective cohort study. *BMJ.* 2017; 357:j1892. doi: doi.org/10.1136/bmj.j1892.
115. Lau, M. S. Y., et al. Optimizing the diagnosis of celiac disease. *Curr Opin Gastroenterol.* 2017; 33:173–180.
116. Premenstrual syndrome (PMS) fact sheet. February 2021. Available at www.womenshealth.gov/publications/our-publications/fact-sheet/premenstrual-syndrome.html, accessed March 26, 2023.
117. O'Brien, P. M., et al. Towards a consensus on diagnostic criteria, measurement and trial design of the premenstrual disorders: The ISPMD Montreal consensus. *Arch Women's Mental Health.* 2011; 14:13–21.
118. Managing premenstrual symptoms, June 2008. Available at www.arhp.org/Publications-and Resources/Quick-Reference-Guide-for Clinicians/PMS/signs, accessed March 26, 2023.
119. Rapkin, A. J., et al. Treatment of premenstrual dysphoric disorder. *Womens Health (Lond Engl).* 2013; 9:537–556.
120. Htay, T. T., et al. Premenstrual dysphoric disorder. Available at emedicine.medscape.com/article/293257, updated May 14, 2012.
121. Freeman, E. W., et al. Clinical subtypes of premenstrual syndrome and responses to sertraline treatment. *Obstet Gynceol.* 2011; 118:1293–1230.
122. Dotinga, R. Genes may play role in more severe form of PMS. 2017. Available at med-lineplus.gov/news/fullstory_162853.html.
123. Yonkers, K. A., et al. Premenstrual syndrome. *Lancet.* 2008; 5:1200–1210.
124. Rapkin, A. J., et al. Treatment of premenstrual dysphoric disorder. *Womens Health (Lond Engl).* 2013; 9:537–556.
125. Ebrahimi, E., et al. Effects of magnesium and vitamin B_6 on the severity of premenstrual syndrome symptoms. *J Caring Sci.* 2012; 1:183–189.
126. Dennehy, C. E. The use of herbs and dietary supplements in gynecology: An evidence-based review. *J Midwifery Womens Health.* 2006; 51:402– 409.
127. What supplements help with PMS. Available at https://www.webmd.com/women/pms/supplements-help-with-pms. Published November 10, 2020.
128. Dubey, N., et al. The ESC/E(Z) complex, an effector of response to ovarian steroids, manifests an intrinsic difference in cells from women with premenstrual dysphoric disorder. *Mol Psychiatry.* 2017 Aug; 22(8):1172–1184. doi: 10.1038/mp.2017.229.
129. MacReady, N. New PMD guidelines emphasizes multidisciplinary approach. 2016. *Medscape.* Available at www.medscape.com/viewarticle/872657.
130. Yen, J.-U., et al. Premenstrual appetite and emotional responses to foods among women with premenstrual dysphoric disorder. *Appetite.* 2018; 125:18–23.
131. Purdue-Smithe, A. C., et al. A prospective study of caffeine and coffee intake and premenstrual syndrome. *Am J Clin Nutr.* 2016; 104:499–507.

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References

Chapter 4

1. Osterman, B. F., et. al. National Center for Health Statistics (US). Births: Final Data for 2021. *Natl Vital Stat Rep*. January 31, 2023. Available at https://stacks.cdc.gov/view/cdc/122047 accessed April 2, 2023.
2. Ely, D., & Driscoll, A., Infant mortality in the United States, 2019: Data from the period linked birth/infant death file. Available at https://www.cdc.gov/nchs/data/nvsr/nvsr70/nvsr70-14.pdf. Published December 8, 2021.
3. Hoyert, D. L. Maternal mortality rates in the United States, 2021. NCHS Health E-Stats, 2023. doi: https://dx.doi.org/10.15620/cdc:124678.
4. Valenzuela, C. P., Gregory, E. C. W., & Martin, J. A. Decline in perinatal mortality in the United States, 2017–2019. NCHS Data Brief, no 429. Hyattsville, MD: National Center for Health Statistics, 2022. doi: https://dx.doi.org/10.15620/cdc:112643external icon.
5. Murphy, S., et al. Mortality in the United States, 2020. Available at https://www.cdc.gov/nchs/data/databriefs/db427.pdf.
6. Healthy People 2030 Maternal, Infant and Child Heath. Available at https://www.health.gov/healthypeople/objectives-and-data/brouse-objectives/pregnancy-and-childbirth.
7. Infant Mortality Rate by Country 2023. Available at https://www.worldpopulationreview.com/country-rankings/infant-mortality-rate-by-country, accessed February 2023.
8. Kamal, R., & Hudmam, J., et al. What do we know about infant mortality in the U.S. and comparable countries. Available at https://www.healthsystemtracker.org/chart-collection/infant-mortality-u-s-compare-countries/. Published October 18, 2019.
9. Thakar, A. P., et al. Child mortality in the US and 19 OECD comparator nations: A 50-year time-trend analysis. *Health Affairs*. January 2018. doi: doi.org/10.1377/hlthaff.2017.0767.
10. Molina, R. L., et al. A renewed focus on maternal health in the United States. *NEJM*. 2017; 377:1705–1707.
11. Williams, R. L., et al. Fetal growth and perinatal viability in California. *Obstet Gynecol*. 1982; 59:624–632.
12. Gregory, E. C. W., Valenzuela, C. P., & Hoyert, D. L. Fetal mortality: United States, 2019. National Vital Statistics Reports; vol. 70, no. 11. Hyattsville, MD: National Center for Health Statistics, 2021. doi: https://dx.doi.org/10.15620/cdc:109456.
13. CDC Fastats, A to Z. Available at www.cdc.gov/nchs/fastats/births.htm, accessed July 15, 2009.
14. Kirkegaard, I., et al. Size at birth and later school performance. *Pediatrics*. 2006; 118:1600–1606
15. Shah, P. E, et al. Gestational age and kindergarten school readiness in a national sample of preterm infants. *J Pediatr*. 2016 Nov; 178:61–67. doi: 10.1016/j.jpeds.2016.06.062. Epub July 25, 2016. PMID: 27470694; PMCID: PMC5085846.
16. Langley-Evans, S. C. Nutrition in early life and the programming of adult disease. *J Human Nutr Diet*. January 2104. doi: 10.1111/jhn.12212.
17. King, J. C. A summary of pathways or mechanisms linking preconception maternal nutrition with birth outcomes. *J Nutr*. 2016; 146(suppl):1437S–1444S.
18. Hytten, F. E., & Leitch, I. *The Physiology of Human Pregnancy*. Oxford: Blackwell Scientific Publications, 1971.
19. Gernand, A. D., et al. Maternal nutritional status in early pregnancy is associated with body water and plasma volume changes in a pregnancy cohort in rural Bangladesh. *J Nutr*. 2012; 142:1109–1115.
20. Vricella, L. K. Emerging understanding and measurement of plasma volume expansion in pregnancy. *Am J Clin Nutr*. 2017; 106(suppl 6)1620S–1625S. doi: https://doi.org/10.3945/ajcn.117.155903.
21. Hytten, F. E., & Leitch, I. *The Physiology of Human Pregnancy*. Oxford, UK: Blackwell Scientific Publications, 1971.
22. Rosso, P. *Nutrition and Metabolism in Pregnancy*. New York, NY: Oxford University Press, 1990:117–118, 125, 150–151.
23. Picciano, M. F. Pregnancy and lactation: Physiological adjustments, nutritional requirements and the role of dietary supplements. *J Nutr*. 2003; 133(6)1997S–2002S. doi: https://doi.org/10.1093/jn/133.6.1997S.
24. Georgieff, M. K. Nutrition and the developing brain: Nutrient priorities and measurement. *Am J Clin Nutr*. 2007; 85(suppl):614S–620S.
25. Mshelia, D. S., et al. The importance of lipid and lipoprotein ratios in interpretations of hyperlipidemia of pregnancy. *J Obstet Gynaecol*. 2010; 30(8):804–808. doi:10.3109/01443615.2010/513457.
26. Butte, N. F. Carbohydrate and lipid metabolism in pregnancy: Normal compared with gestational diabetes mellitus. *Am J Clin Nutr*. 2000; 71:1256S–1261S.
27. Mshelia, D. S., et al. The importance of lipid and lipoprotein ratios in interpretations of hyperlipidemia of pregnancy. *InTech*. 2012 October. doi: dx.doi.org/10.5772/46064.
28. Parrettini S., et al. Nutrition and Metebolic Adaptions in Physiological and Complicated Pregnancy: Focus on Obesity and Gestational. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7793966/Diabetes. Published online November 30, 2020.
29. Wiznitzer, A., et al. Association of lipid levels during gestation with preeclampsia and gestational diabetes mellitus: A population-based study. *Am J Obstet Gynecol*. 2009; 201:482.e1–482.e8.
30. Saarelainen, H., et al. Pregnancy-related hyperlipidemia and endothelial function in healthy women. *Circ J*. 2006; 70:768–772.
31. Arora, G. P., et al. Insulin secretion and action in North Indian women during pregnancy. *Diabetic Med*. 2017; 34:1477–1482.
32. Khoury, J. et al. Effect of a cholesterol-lowering diet on maternal, cord, and neonatal lipids, and pregnancy outcomes: A randomized clinical trial. *Am J Obstet Gynecol*. 2005; 193:1292–1301.
33. Catov, J., et al. Early pregnancy atherogenic profile in a first pregnancy and hypertention risk 2 to 7 years after delivery. Available at https://www.ahajournals.org/doi/10.1161/JAHA.120.017216. Published February 23, 2021.
34. King, J. C. Effect of reproduction on the bioavailability of calcium, zinc and selenium. *J Nutr*. 2001; 131:1355S–1358S.
35. Best Practices: Overview of Pregnancy Complications, Salt Restriction. February 14, 2011. Available at bestpractice.bmj.com/best-practice/monograph/494/overview/evidence/intervention/1402/0/sr-1402-i10.html, accessed August 20, 2012.
36. American College of Obstetricians and Gynecologists. Nutrition during pregnancy. *ACOG Technical Bulletin No. 179*. 1993; 1–7.
37. Desoye, G., et al. Placental transport in pregnancy pathologies. *Am J Clin Nutr*. 2011; 95(suppl):1895S–1902S.
38. Kourtis, A. P., et al. Pregnancy and infection. *N Engl J Med*. 2014; 370:2211–2218.
39. Gude, N. M., et al. Growth and function of the normal human placenta. *Thromb Res*. 2004; 114:397–407.
40. Trahair, J. F., et al. Ultrastructural anomalies in the fetal small intestine indicate that fetal swallowing is important for normal development: An experimental study. *Virchows Arch A Pathol Anat Histopathol*. 1992; 420:305–312.
41. Scholl, T. O., et al. Leptin and maternal growth during adolescent pregnancy. *Am J Clin Nutr*. 2000; 72:1542–7.35.
42. Rosso, P., et al. Intrauterine growth retardation: A new systematic approach based on the clinical and biochemical characteristics of this condition. *J Perinat Med*. 1974; 2:147–160.
43. Georgieff, M. K. Nutrition and the developing brain: Nutrient priorities and measurement. *Am J Clin Nutr*. 2007; 85(suppl):614S–620S.
44. Biga, L. M., et al. Anatomy & Physiology. 2019. Licensed under a Creative Commons Attribution-ShareAlike 4.0 International License. Available at https://open.oregonsgtate/aandp/chapter/19-5-development-of-the-heart, accessed April 6, 2023.
45. Gluckman, P. D. Fetal origins of adult disease: Insulin resistance. *Medscape. Ob/Gyn & Women's Health*. 2003; 8:4–5.
46. Smith, D. W. (1979). Growth and its disorders: Basics and standards, approach and classifications, growth deficiency disorders, growth excess disorders, obesity. In Schaeffer, A. J., & Markowitz, M. (Eds.), *Major Problems in Clinical Pediatrics* (vol. 15). Philadelphia, PA: W. B. Saunders Company, 1979:134–169.
47. Winick, M. Malnutrition and brain development. *J Pediatr*. 1969; 74:667–679.
48. Godfrey, K. M., et al. Fetal nutrition and adult disease. *Am J Clin Nutr*. 2000; 71:1344S–1352S.

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References

49. Calkins, K., & Devaskar, S. U. Fetal origins of adult disease. *Curr Probl Pediatr Adolesc Health Care*. 2011 Jul; 41(6):158–176. doi: 10.1016/j.cppeds.2011.01.001. PMID: 21684471; PMCID: PMC4608552.
50. Grantz, K. L., et al. Unified standard for fetal growth: The Eunice Kennedy Shriver National Institute of Child Health and Human Development Fetal Growth Studies. *AJOG*. 2022; 226(4):576–587. doi: https://doi.org/10.1016/jajog.2021.12.006.
51. Smits, I., et al. Neonatal hypoglycaemia and body proportionality in small for gestational age newborns: A retrospective cohort study. *Eur J Pediatr*. 2022; 181:3655–3662. doi: https://doi.org/10.1007/s00431-022-04592-8.
52. Bocca-Tjeertes I., et al. Symmetrical and asymmetrical growth restriction in preterm-born children. *Pediatrics*. 2014 Mar; 133(3):e650–656. doi: 10.1542/peds.2013-1739. Epub February 2, 2014. PMID: 24488742
53. Intrauterine Growth Restriction and Small for Gestation Age. American Pregnancy Association. Available at https://americanpregnancy.org/healthy-pregnancy/pregnancy-complication/intrauterine-growth-restriction, accessed April 8, 2023.
54. National Academy of Sciences. *Nutrition During Pregnancy. I. Weight Gain. II. Nutrient Supplements*. Washington, DC: National Academy Press, 1990.
55. Hediger, M. L., et al. Growth of infants and young children born small or large for gestational age: Findings from the Third National Health and Nutrition Examination Survey. *Arch Pediatr Adolesc Med*. 1998; 152:1225–1231.
56. Beukers, F., et al. Growth throughout childhood of children born growth restricted. *Arch Dis Child*. 2017; 102:735–741.
57. Dearden, L., et al. The road between early growth and obesity: New twists and turns. *Am J Clin Nutr*. 2014; 100:6–7.
58. Jolly, M. C., et al. Risk factors for macrosomia and its clinical consequences: A study of 350,311 pregnancies. *Eur J Obstet Gynecol Repro Biol*. 2003; 111:9–14.
59. Wang, L., et al. Association of Gestational Weight Gain with Infant Morbidity and Mortality in the United States. Available at https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2787597. Published December 30, 2021.
60. Luo, Z. C., et al. Length and body mass index at birth and target height influences on patterns of postnatal growth in children born small for gestational age. *Pediatrics*. 1998; 102:E72.
61. Zhang, G., et al. Genetic associations with gestational duration and spontaneous preterm birth. *N Engl J Med*. 2017; 3877:1156–1167. doi: 10.1056/NEJMoa1612665.
62. Branch, D. W., et al. Recurrent miscarriage. *N Engl J Med*. 2010; 363:1740–1747.
63. Kovacs, P. Exercise, pregnancy, and preterm birth: What advice can we give? *Medscape*, February 27, 2018. Available at www.medscape.com/viewarticle/892574?src=wnl_mdplsnews_180302_mscpedit_wir&uac=61213SX&impID=1572061&faf=1.
64. Kwak-Kim, J., et al. Managing women with recurrent pregnancy losses and antiphospholipid syndrome. *Am J Repro Immunol*. 2013; 69:595–607.
65. Maconochile, N., et al. Underweight and the risk of miscarriage. Online edition of *BJOG: An International Journal of Obstetrics and Gynecology*. Published December 4, 2006. Available at www.medicinenet.com/script/main/art.asp?articlekey=77914, accessed April 8, 2023.
66. Montserrat, B. Systematic review and meta-analysis on the association of prepregnancy underweight and miscarriage. *Euro J Obstet & Gyn Reprod Biol*. 2016; 207:73–79. doi: https://doi.org/10.1016/j.ejogrb.2016.10.012.
67. Pearson, A. C., & Mahmood, T. A. *Chapter 10 - Obesity and Recurrent Miscarriage*. In Mahmood, T. A., Arulkumaran, S., & Chervenak, F. A. (Eds.), *Obesity and Gynecology* (2nd ed., pp. 91–96). Elsevier, 2020, ISBN 9780128179192. doi: https://doi.org/10.1016/B978-0-12-817919-2.00010-3.
68. Benammar, A., et al. Nutrition and miscarriages: A literature review. *Gynecol Obstet Fertil*. March 2012; 40:162–169.
69. Catov, J. M., et al. Inflammation and dyslipidemia related to risk of spontaneous preterm birth. *Am J Epidemiol*. 2007; 166:1312–1319.
70. Hand, L. Misconceptions about cause, frequency of miscarriage common. October 2013. Available at www.medscape.com/viewarticle/813084, accessed April 8, 2023.
71. Williams, Z. Inducing tolerance to pregnancy. *N Engl J Med*. 2012; 367:1159–1162.
72. Hudson, K. L., et al. In support of SUPPORT—A view from the NIH. *N Engl J Med*. 2013; 368:2349–2352.
73. Elizabeth, K. E., et al. Umbilical cord blood nutrients in low birth weight babies in relation to birth weight & gestational age. *Indian J Med Res*. 2008; 128:128–133.
74. Kramer, M. S., et al. The contribution of mild and moderate preterm birth to infant mortality. Fetal and Infant Health Study Group of the Canadian Perinatal Surveillance System. *JAMA*. 2000; 284:843–849.
75. Ortega, R. M., et al. Riboflavin levels in maternal milk: The influence of vitamin B_2 status during the third trimester of pregnancy. *J Am Coll Nutr*. 1999; 18:324–329.
76. Chery, C., et al. Hyperhomocysteinemia is related to a decreased level of vitamin B_{12} in the second and third trimesters of pregnancy. *Clin Chem Lab Med*. 2002; 40:1105–1108.
77. Keikha, M., et al. Macro- and micronutrients of human milk composition: Are they related to maternal diet? A comprehensive systematic review. *Breastfeed Med*. 2017; 12(9):517–527.
78. Allen, L. A. Multiple micronutrients in pregnancy and lactation: an overview. *Am J Clin Nutr*. 2005; 81(5):1206S–1212S. doi: https://doi.org/10.1093/ajcn/81.5.1206.
79. Hollis B. W., et al. Maternal versus infant vitamin D supplementation during lactation: A randomized controlled trial. *Pediatrics*. 2015 Oct; 136(4):625–634. doi: 10.1542/peds.2015-1669. Erratum in: *Pediatrics*. 2019 Jul; 144(1): PMID: 26416936; PMCID: PMC4586731.
80. Siega-Riz, M., et al. Second trimester folate status and preterm birth. *Am J Obstet Gynecol*. 2004; 191:1851–1857.
81. Bukowski, R., et al. Preconceptional folate supplementation and the risk of spontaneous preterm birth: A cohort study. *PLoS Med*. 2009; 6(5):e1000061. doi: 10.1371/journal.pmed.1000061.
82. Haugen, M., et al. Mediterranean-type diet and risk of preterm birth among women in the Norwegian Mother and Child Cohort Study (MoBa): A prospective cohort study. *Acta Obstet Gynecol Scand*. 2008; 87(3):319–324.
83. Klebanoff, M., et al. Fish consumption, erythrocyte fatty acids, and preterm birth. *Obstet Gynecol*. 2011; 117:1071–1077.
84. Grieger, J. A., et al. Preconception dietary patterns in human pregnancies are associated with preterm delivery. *J Nutr*. 2014; 144:1075–1080.
85. Sasaki, S., et al. Interaction between maternal caffeine intake during pregnancy and CYP1A2 C164A polymorphism affects infant birth size in the Hokkaido study. *Pediatric Res*. 2017; 82:19–28.
86. Maslova, E., et al. Caffeine consumption during pregnancy and risk of preterm birth: A meta-analysis. *Am J Clin Nutr*. 2010; 92:1120–1132.
87. Yang, Z., et al. Contribution of maternal overweight and obesity to the occurrence of pregnancy outcomes. Available at https://obgyn.onlinelibrary.wiley.com/doi/full/10.1111/ajo.12866. Published July 19, 2018.
88. Juhl, M., et al. Physical exercise during pregnancy and the risk of preterm birth: A study within the Danish national birth cohort. *Am J Epidemiol*. 2008; 167:859–866.
89. Magro-Malosso, E. R., et al. Exercise during pregnancy and risk of preterm birth in overweight and obese women: A systematic review and meta-analysis of randomized controlled trials. *Acta Obstet Gynecol Scand*. 2017; 96:362–373.
90. Brantsæter, A. L., et al. Maternal intake of seafood and supplementary long chain n-3 poly-unsaturated fatty acids and preterm delivery. *BMC Preg Childbirth*. 2017; 17(1):61. doi: doi.org/10.1186/s12884-017-1225-8.
91. Catov, J. M., et al. Early pregnancy lipid concentrations and spontaneous preterm birth. *Am J Obstet Gynecol*. 2007; 197:610. e1–e7.
92. Chen, X., et al. Association of elevated free fatty acids during late pregnancy with preterm delivery. *Obstet Gynecol*. 2008; 112:297–303.

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References

93. Fried, M., et al. Systemic inflammatory response to malaria during pregnancy is associated with pregnancy loss and preterm delivery. *Clin Infectious Dis*. 2017; 65:1729–1735.
94. Susser, M., et al. Timing in prenatal nutrition: A reprise of the Dutch Famine Study. *Nutr Rev*. 1994; 52:84–94.
95. Hsu, C. N., & Tain, Y. L. The good, the bad, and the ugly of pregnancy nutrients and developmental programming of adult disease. *Nutrients*. 2019; 11(4):894. doi: https://doi.org/10.3390/nu11040894.
96. Gluckman, P. D., et al. Effect of *in utero* and early-life conditions on adult health and disease. *N Engl J Med*. 2008; 359:61–73.
97. Smith, C., et al. The impact of birth weight on cardiovascular disease risk in women's health initiative. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4788544/#:~:text=This%20deficiency%20may%20result%20in,2%20diabetes%2C%20and%20metabolic%20syndrome. Published November 18, 2015.
98. Irene Woo, I., et al. Perinatal outcomes after natural conception versus in vitro fertilization (IVF) in gestational surrogates: a model to evaluate IVF treatment versus maternal effects. *Fert Steril*. 2017; 108(6); 993–998. ISSN 0015 doi.org/10.1016/j.fertnstert.2017.09.014.
99. Ma, R. C. W., et al. Maternal diabetes, gestational diabetes and the role of epigenetics in their long-term effects on offspring. *Prog Biophys Mol Biol*. March 16, 2015. doi: 10.1016/j.pbiomolbio.2015.02.010.
100. Gabory, A., et al. Developmental programming and epigenetics. *Am J Clin Nutr*. 2011; 94(6 suppl):1943S–1952S.
101. Vickers, M. H. Developmental programming of the metabolic syndrome—critical windows for intervention. *World J Diabetes*. 2011; 15(2):137–148.
102. Robinson, S. M., et al. Combined effects of dietary fat and birth weight on serum cholesterol concentrations: The Hertfordshire Cohort Study. *Am J Clin Nutr*. 2006; 84:237–244.
103. Kuzawa, C. W., et al. Lipid profiles in adolescent Filipinos: Relation to birth weight and maternal energy status during pregnancy. *Am J Clin Nutr*. 2003; 77:960–966.
104. Stein, A. D. Nutrition in early life and cognitive functioning. *Am J Clin Nutr*. 2014; 99:1–2.
105. To, W. W., et al. The relationship between weight gain in pregnancy, birthweight and postpartum weight retention. *Aust N Z J Obstet Gynaecol*. 1998; 38:176–179.
106. Anil, K. C., et al. Low birth weight and its associated risk factors. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7307746/. Published online June 22, 2020.
107. Eastman, N. J. *Expectant Motherhood*. Boston, MA: Little, Brown and Company, 1947:198.
108. Weight Gain During Pregnancy. Available at https://www.cdc.gov/reproductivehealth/maternalinfanthealth/pregnancy-weight-gain.htm.
109. Nohr, E. A., et al. Combined associations of prepregnancy body mass index and gestational weight with the outcome of pregnancy. *Am J Clin Nutr*. 2008; 87:1750–1759.
110. Pregnancy Nutrition Surveillance. Available at www.cdc.gov/pednss/pdfs/PNSS_2009.pdf, accessed August 21, 2012.
111. Goldstein, R. F., et al. Association of gestational weight gain with maternal and infant outcomes. A systematic review and meta-analysis. *JAMA*. 2017; 317:2207–2225.
112. Retnakaran, R., et al. Association of timing of weight gain in pregnancy with infant birth weight. *JAMA Pediatr*. 2018 Feb 1; 172(2):136–142. doi: 10.1001/jamapediatrics.2017.4016.
113. Broskey, N. T., et al. Early pregnancy weight gain exerts the strongest effect on birth weight, posing a critical time to prevent childhood obesity. *Obesity*. 2017; 25:1569–1576.
114. Siega-Riz, A. M. A systematic review of outcomes of maternal weight gain according to the Institute of Medicine recommendations: Birthweight, fetal growth, and postpartum weight retention. *Am J Obstet Gynecol*. 2009; 201:339.e1–e14.
115. Nehring, I., et al. Gestational weight gain and long-term postpartum weight retention: A meta-analysis. *Am J Clin Nutr*. 2011; 94:1225–1231.
116. Leonard, S. A., et al. Trajectories of maternal weight from before pregnancy through postpartum and associations with childhood obesity. *Am J Clin Nutr*. 2017; 106:1295–1302.
117. Andersson, E. S., et al. No association of maternal gestational weight gain with offspring blood pressure and hypertension at age 18 years in male sibling-pairs: A prospective register-based cohort study. *PLOS One*. Published March 20, 2015. doi: 10.1371/journal.pone.0121202.
118. Nohr, E. A., et al. Combined associations of prepregnancy body mass index and gestational weight with the outcome of pregnancy. *Am J Clin Nutr*. 2008; 87:1750–1759.
119. Mackay, E., et al. Association of gestational weight gain and maternal body mass index in early pregnancy with risk for nonaffective psychosis in offspring. *JAMA Psychiatry*. 2017; 74(4):339–349.
120. Brown, J. E., et al. Variation in newborn size by trimester weight change in pregnancy. *Am J Clin Nutr*. 2002; 76:205–209.
121. Carmichael, S. L., et al. A critical review of the relationship between gestational weight gain and preterm delivery. *Obstet Gynecol*. 1997; 89:865–873.
122. To, W. W., et al. The relationship between weight gain in pregnancy, birthweight and postpartum weight retention. *Aust N Z J Obstet Gynaecol*. 1998; 38:176–179.
123. Keppel, K. G., et al. Pregnancy-related weight gain and retention: Implications of the 1993 Institute of Medicine guidelines. *Am J Public Health*. 1993; 83:1100–1103.
124. Nehring, I., et al. Gestational weight gain and long-term postpartum weight retention: A meta-analysis. *Am J Clin Nutr*. 2011; 94:1225–1231.
125. Gunderson, E. P., et al. Does the pattern of postpartum weight change differ according to pregravid body size? *Int J Obes*. 2001; 25:853–862.
126. Rode, L., et al. Association between gestational weight gain according to body mass index and postpartum weight in a large cohort of Danish women. *Matern Child Health J*. March 24, 2012; 16(2):406–413.
127. Lau, E.Y., et al. Maternal weight gain in pregnancy and risk of obesity among offspring: A systematic review. *J Obes*. 2014; 2014:524939. doi: doi.org/10.1155/2014/524939.
128. Kahn, K. S., et al. Effect of diet and physical activity based interventions in pregnancy on gestational weight gain and pregnancy outcomes: Meta-analysis of individual participant data from randomised trials. *BMJ*. 2017; 358:j3119.
129. Kahn, K. S., et al. Effect of diet and physical activity based interventions in pregnancy on gestational weight gain and pregnancy outcomes: Meta-analysis of individual participant data from randomised trials. *BMJ*. 2017; 358:j3119.
130. 2020 Dietary Guidelines Advisory Committee. Advisory report to the Secretary of Health and Human Services and Secretary of Agriculture. Published June 30, 2020. Available at https://www.dietaryguidlines.gov/2020-advisory-committee-report.
131. Mussey, R. D. Nutrition and human reproduction: An historical review. *Am J Obstet Gynecol*. 1949; 58:1037–1048.
132. Stein, A. D., et al. Famine, third-trimester pregnancy weight gain, and intrauterine growth: The Dutch Famine Birth Cohort Study. *Hum Biol*. 1995; 67:135–150.
133. Carmichael, S. L., et al. Reduced risks of neural tube defects and orofacial clefts with higher diet quality. *Arch Pediatr Adolesc Med*., published online October 3, 2011. doi: 10.1001/archpediatrics.2011. 185.
134. Susser, M., et al. Timing in prenatal nutrition: A reprise of the Dutch Famine Study. *Nutr Rev*. 1994; 52:84–94.
135. Roseboom, T. J., et al. Plasma lipid profiles in adults after prenatal exposure to the Dutch famine. *Am J Clin Nutr*. 2000; 72:1101–1106.
136. Rodríguez-Bernal, C. L., et al. Diet quality in early pregnancy and its effects on fetal growth outcomes: The Infancia y Medio Ambiente (Childhood and Environment) Mother and Child Cohort Study in Spain. *Am J Clin Nutr*. 2010; 91:1659–1666.
137. Butte, N. F. Energy requirements during pregnancy and consequences of deviations from requirement on fetal outcome. *Nestle Nutr Workshop Ser Pediatr Program*. 2005; 55:49–67.
138. United Nations live births, deaths, and infant mortality rate. Available at unstats.un.org/unsd/demographic/products/vitstats/serATab3.pdf, accessed 2019.

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References

139. Huang, C., et al. Early life exposure to the 1959–1961 Chinese famine has long-term health consequences. *J. Nutr.* 2010; 140; 1874–1878.
140. Simic, S., et al. Nutritional effects of the siege on newborn babies in Sarajevo. *Eur J Clin Nutr.* 1995; 49(Suppl. 2):S33–S36.
141. Lumey, L. H., et al. Prenatal famine and adult health. *Ann Rev Pub Health.* 2011; 32:237–262.
142. Burke, B. S. Nutritional needs in pregnancy in relation to nutritional intakes as shown by dietary histories. *Obstetr Gynecol Survey.* 1948; 3:716–730.
143. Burke, B. S., et al. Nutrition studies during pregnancy. IV. Relation of protein content of mother's diet during pregnancy to birth length, birth weight, and condition of infant at birth. *J Pediatr.* 1943; 23:506–515.
144. National Academies of Sciences, Engineering, and Medicine. 2023. Dietary Reference Intakes for Energy. Washington, DC: The National Academies Press. doi: https://doi.org/10.17226/26818.
145. Brown, J. E., et al. Maternal nutrition and the outcome of pregnancy: A renaissance in research. *Clin Perinatol.* 1997; 24:433–449.
146. Position of the Academy of Nutrition and Dietetics: Nutrition and lifestyle for a healthy pregnancy outcome. *J Acad Nutr Diet.* 2014; 114:1099–1103.
147. Starling, A. P., et al. Maternal dietary patterns during pregnancy are associated with newborn body composition. *J Nutr.* 2017; 47:1334–1339.
148. Mousa, A., Naqash, A., & Lim, S. Macronutrient and micronutrient intake during pregnancy: An overview of recent evidence. *Nutr.* 2019; 11(2):443. doi: https://doi.org/10.3390/nu11020443.
149. Danielewicz, H., et al. Diet in pregnancy—more than food. *Eur J Pediatr.* 2017; 176:1573–1579.
150. Nutrient Intakes from Food and Beverages: Mean Amounts Consumed per Individual, by Gender and Age, What We Eat in America, NHANES 2017–2018. *Agricultural Research Service.* 2014. Available at www.ars.usda.gov/ARSUserFiles/80400530/pdf1718/Table_1_NIN_GEN_17.pdf, accessed April 8, 2023.
151. Deierlein, A. L., et al. Dietary energy density but not glycemic load is associated with gestational weight gain. *Am J Clin Nutr.* 2008; 88:693–699.
152. Suez, J., et al. Artificial sweeteners induce glucose intolerance by altering the gut microbiota. *Nature.* 2014; 514:181–186.
153. Pearlman, M., et al. The association between artificial sweeteners and obesity. *Current Gastroent Rpts.* 2017 Nov; 19(12):64. doi: 10.1007/s11894-017-0602-9.
154. Zhu, Y., et al. Maternal consumption of artificially sweetened beverages during pregnancy, and offspring growth through 7 years of age: A prospective cohort study. *Am J Epidemiol.* 2017; 46:1499–1508.
155. Pyror, J., et al. Pregnancy intention and maternal alcohol consumption. *Obstet Gynecol.* 2017; 129:727–733.
156. Popova, S., et al. Estimation of national, regional, and global prevalence of alcohol use during pregnancy and fetal alcohol syndrome: A systematic review and meta-analysis. *Lancet Global Health.* 2017; 5:e290–e299.
157. Sundelin-Wahlsten, V., et al. Higher alcohol consumption in early pregnancy or low-to-moderate drinking during pregnancy may affect children's behaviour and development at one year and six months. *Acta Paediatrica.* 2016. doi: doi.org/10.1111/apa.13664.
158. Chambers, C., et al. Prenatal alcohol exposure patterns and alcohol-related birth defects and growth deficiencies: A prospective study. Alcoholism. *Clin Exper Res.* Article first published online January 17, 2012. doi: 10.1111/j.1530-0277.2011.01664.x.
159. *Dietary Reference Intakes: Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids.* Washington, DC: National Academies Press, 2002.
160. Moore, V. M., et al. Dietary composition of pregnant women is related to size of the baby at birth. *J Nutr.* 2004; 134:1820–1826.
161. Royall D. Omega-3 recommendations for pregnancy. *Canadian J Dietetic Pract Res.* 2017; 78:52.
162. Williams, C. M., et al. Long-chain n-3 PUFA: Plant v. marine sources. *Proc Nutr Soc.* 2006; 65:42–50.
163. Position of the American Dietetic Association and Dietitians of Canada: Dietary fatty acids. *J Am Diet Assoc.* 2007; 107:1599–1611.
164. Harris, W. S., et al. Towards establishing dietary reference intakes for EPA and DHA. *J Nutr.* 2009; 139:804S–819S.
165. Swanson, D., et al. Omega-3 fatty acids EPA and DHA: Health benefits throughout life. *Adv Nutr.* 2012; 3:1–7.
166. Harris, W. S., et al. Towards establishing dietary reference intakes for eicosapentaenoic and docosahexaenoic acids. *J Nutr.* 2009; 139:804S–819S.
167. Advice about eating fish. For those who might become pregnant are pregnant, are breastfeeding, and for children. Available at https://www.epa.gov/fish-tech/epa-fda-advice-about-eating-fish-and-shellfish, accessed April 8, 2023.
168. Ostadrahimi, A., et al. The effect of perinatal fish oil supplementation on neurodevelopment and growth of infants: A randomized controlled trial. *Euro J Nutr.* July 21, 2017. Available at https://link.springer.com/article/10.1007/s00394-017-1512-1.
169. Lehman, S. DHA supplements during pregnancy don't raise kids' IQ. Available at http://www.medscape.com/viewarticle/877872?nlid=113829_2042&src=WNL_mdplsnews_170331_mscpedit_obgy&uac=61213SX&spon=16&impID=1320249 &faf=1, accessed April 8, 2023.
170. Smithells, R. W. Availability of folic acid. *Lancet.* 1984; 1:508. doi: doi.org/10.1016/SO140-6736(84)92868-X.
171. Treiman, V., et al. Folic acid supplementation for the prevention of neural tube defects. Available at https://jamanetwork.com/journals/jama/fullarticle/2596300. Published January 10, 2017.
172. Suitor, C. W., et al. Dietary folate equivalents: Interpretation and application. *J Amer Diet Assoc.* 2000; 100:88–94.
173. Anthony, A. C. *In utero* physiology: Role of folic acid in nutrient delivery and fetal development. *Am J Clin Nutr.* 2007; 85(Suppl):598S–603S. 168:2020–2023.
174. Yang, Q., et al. Prospective study of methyl-enetetrahydrofolate reductase (MTHFR) variant C677T and risk of all-cause cardiovascular mortality among 6000 US adults. *Am J Clin Nutr.* 2012; 95:1245–1253.
175. Greenberg, J. A., et al. Folic acid supplementation and pregnancy: More than just neural tube defect prevention. *Rev Obstet Gynecol.* 2011; 4:52–59.
176. Warkany, J. Production of congenital malformations by dietary measures. *JAMA.* 1958; 168:2020–2023.
177. Eskes, T. K. A. B. From birth to conception, open or closed. *Eur J Obstet Gynecol Reprod Biol.* 1998; 78:169–177.
178. Folic acid. *MMWR Morb Mortal Wkly Rep.* 2001; 50:185–189.
179. Maffoni, S., et al. Folic status in women of childbearing age with obesity. *Nutr Res Rev.* 2017 Dec; 30(2):265–271. doi: 10.1017/S0954422417000142. Epub June 7, 2017. PMID: 28587698; PMCID: PMC6232191.
180. Guo, T., et al. Methylenetetrahydrofolate reductase polymorphisms C677T and risk of autism in the Chinese Han population. *Genet Test Mol Biomarkers.* 2012; 16(8):968–973.
181. Dunlap, B., et al. Folic acid and human reproduction—ten important issues for clinicians. *J Exp Clin Assist Reprod.* 2011; 8:2. Published online August 10, 2011. Available at www.ncbi.nlm.nih.gov/pmc/articles/ PMC3183498/?tool=pmcentrez.
182. Daly, L. E., et al. Folate levels and neural tube defects. *JAMA.* 1995; 274:1698–1702.
183. Pfeiffer, C. M., et al. Estimation of trends in serum and RBC folate in the U.S. population from pre- to postfortification using assay-adjusted data from the NHANES 1988–2010. *J Nutr.* 2012; 142:886–893.
184. Shane, B. Folate-responsive birth defects: Of mice and women. *Am J Clin Nutr.* 2012; 95:1–2.
185. Folic acid recommendations. Last reviewed June 2022. Available at www.cdc.gov/ncbddd/folicacid/recommendations.html, accessed April 8, 2023.
186. Viswanathan, V., et al. Folic acid supplementation for the prevention of neural tube defects: An updated evidence report and systematic review for the US Preventive Services Task Force. *JAMA.* 2017; 317(2):190–203.

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References

187. Pauwels, S., et al. Dietary and supplemental maternal methyl-group donor intake and cord blood DNA methylation. *Epigenetics*. 2016. doi: doi.org/10.1080/15592294.2016.1257450.
188. Velzing-Aarts, F. V., et al. Plasma choline and betaine and their relation to plasma homocysteine in normal pregnancy. *Am Clin Nutr.* 2005; 81:1383–1389.
189. Yan, J., et al. Pregnancy alters choline dynamics: Results of a randomized trial using stable isotope methodology in pregnant and nonpregnant women. *Am J Clin Nutr.* 2013; 98:459–467.
190. Signore, C., et al. Choline concentrations in human maternal and cord blood and intelligence at 5 y of age. *Am J Clin Nutr.* 2008; 87:896–902.
191. Mathews-Roth, M. M., et al. Lack of genotoxicity with beta-carotene. *Tox Letters*. 1988; 41:L185–191.
192. Zile, M. H. Function of vitamin A in vertebrate embryonic development. *J Nutr.* 2001; 131:705–708.
193. Werner, C. A., et al. Women's experiences with isotretinoin risk reduction counselling. *JAMA Dermatol*. Published online November 20, 2013. doi: doi:10.1001/jamadermatol.2013.6862.
194. Lott, I. T., et al. Fetal hydrocephalus and ear abnormalities associated with maternal use of isotretinion. *J Pediatr.* 1984; 105:597–600.
195. Brooks, M. PRAC seeks new pregnancy prevention measures for retinoids. 2018. Available at www.medscape.com/viewarticle/892514.
196. Thielitz, A., et al. Topical retinoids in acne vulgaris: Update on efficacy and safety. *Am J Clin Dermatol.* 2008; 9:369–381.
197. McCullough, M. L. Vitamin D deficiency in pregnancy: Bringing the issue to light. *J Nutr.* 2007; 137:305–306.
198. Macones, G. A., et al. Vitamin D: Screening and supplementation during pregnancy. *Obstet Gynecol*. 2011; 118:197–198.
199. Hart, P. H., et al. Vitamin D in fetal development: Findings from a Birth Cohort Study. *Pediatrics*. Published online December 15, 2014. doi: 10.1542/peds.2014-1860.
200. Shroth, R., et al. Influence of maternal vitamin D status on infant oral health, Abs. no. 1646, *International Association for Dental Research*, July 4, 2008.
201. Dror, D. K., et al. Vitamin D inadequacy in pregnancy: Biology, outcomes, and interventions. *Nutr Rev.* 2010; 68:465–477.
202. Ota, K., et al. Vitamin D deficiency may be a risk factor for recurrent pregnancy losses by increasing cellular immunity and autoimmunity. *Hum Reprod*. 2014; 29:208–219.
203. Darling, A. L., et al. Association between maternal vitamin D status in pregnancy and neurodevelopmental outcomes in childhood: Results from the Avon Longitudinal Study of Parents and Children (ALSPAC). *Br J Nutr.* 2017; 117:1682–1692.
204. Daraki, V., et al. Low maternal vitamin D status in pregnancy increases the risk of childhood obesity. *Pediatr Obesity*. 2018. doi: doi.org/10.1111/ijpo.1226.
205. Schneuer, F. J., et al. Effects of maternal serum 25-hydroxyvitamin D concentrations in the first trimester on subsequent pregnancy outcomes in an Australian population. *Am J Clin Nutr.* 2014; 99:287–295.
206. Kovacs, C. S. Vitamin D in pregnancy and lactation: Maternal, fetal, and neonatal outcomes from human and animal studies. *Am J Clin Nutr.* 2008; 88(suppl):520S–528S.
207. Bodnar, L. M., et al. High prevalence of vitamin D insufficiency in black and white women residing in the northern United States and their neonates. *J Nutr.* 2007; 137:447–452.
208. Saleem, N., Rizvi, N. B., & Elahi, S. Prevalence of vitamin D deficiency and its association with insulin resistance in obese women with normal fasting glucose. *Biomed Res Int*. 2021 Dec 14; 2021:2259711. doi: 10.1155/2021/2259711. PMID: 34950730; PMCID: PMC8691995.
209. Hollis, B. W., et al. Vitamin D supplementation during pregnancy: Double-blind, randomized clinical trial of safety and effectiveness. *J Bone Min Res*. June 27, 2011. doi: 10.1002/jbmr.463.
210. Hollis, B. W., et al. Vitamin D supplementation during pregnancy: Double-blind, randomized clinical trial of safety and effectiveness. *J Bone Min Res.* June 27, 2011. doi: 10.1002/jbmr.463.
211. Macones, G. A., et al. Vitamin D: Screening and supplementation during pregnancy. *Obstet Gynecol.* 2011; 118:197–198.
212. Tangpricha, V. Vitamin D in food and supplements. *Am J Clin Nutr.* 2012; 95:1299–1300.
213. O'Brien, K. O., et al. Serum 1, 25-dihydroxyvitamin D and calcium intake affect rates of bone calcium deposition during pregnancy and the early postpartum period. *Am J Clin Nutr.* 2012; 96:64–72.
214. Olausson, H., et al. Changes in bone mineral status and bone size during pregnancy and the influence of body weight and calcium intake. *Am J Clin Nutr.* 2008; 8:1032–1039.
215. Abduweli D., et al. Maternal and fetal exposures to fluoride during mid -gestation among pregnant women in northern California. Available at https://ehjournal.biomedcentral.com/articles/10.1186/s12940-020-00581-2, Published April 6, 2020.
216. Stefanie, L. Exploring potential pathways between parity and tooth loss among American women. *Am J Public Health*. 2008; 98:1263–1270.
217. Essential nutrition actions improving maternal–newborn–infant and young child health and nutrition. June 2013. Available at https://www.who.int/publications/i/item/9789241505550, accessed April 8, 2023.
218. Brannon, P., & Taylor, C. Iron supplementation during pregnancy and infancy. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5748777/.
219. Mei, Z., et al. Assessment of iron status in US pregnant women from the National Health and Nutrition Examination Survey (NHANES), 1999–2006. *Am J Clin Nutr.* 2011; 93:1312–1320.
220. Brannon, P. M., et al. Iron supplementation during pregnancy and infancy: Uncertainties and implications for research and policy. *Nutrients*. 2017; 9(12):1327. doi: 10.3390/nu9121327.
221. Cantor, A. G., et al. Routine iron supplementation and screening for iron deficiency anemia in pregnancy: A systematic review for the U.S. Preventive Services Task Force. *Ann Intern Med*. 2015 Apr 21; 162(8):566–576. doi: 10.7326/M14-2932. Published online March 30, 2015.
222. Allen, L. H. Biological mechanisms that might underlie iron's effects on fetal growth and preterm birth. *J Nutr.* 2001; 131:581S–589S.
223. Allen, L. H. Anemia and iron deficiency: Effects on pregnancy outcome. *Am J Clin Nutr.* 2000; 71:1280S–1284S.
224. Jacqueline Frayne, J., et al. Reproductive planning, vitamin knowledge and use, and lifestyle risks of women attending pregnancy care with a severe mental illness. *Scand J Prim Health Care*. 2021; 39(1):60–66.
225. Abel, M. H., et al. Suboptimal maternal iodine intake is associated with impaired child neurodevelopment at 3 years of age in the Norwegian Mother and Child Cohort Study. *J Nutr.* July 2017; 147:1314–1324.
226. Pearce, E. N., et al. Consequences of iodine deficiency and excess in pregnant women: An overview or current knowns and unknowns. *Am J Clin Nutr.* 2016; 104(suppl):918S–923S.
227. Mahomed, K., et al. Maternal iodine supplements in areas of deficiency (Cochrane Review). The Cochrane Library. Issue 3. Oxford, UK: Update Software, 1999.
228. Mahomed, K., et al. Maternal iodine supplements in areas of deficiency (Cochrane Review). The Cochrane Library. Issue 3. Oxford, UK: Update Software, 1999.
229. Leung, A. M., et al. AAP recommendations on iodine nutrition during pregnancy and lactation. *Pediatrics*. 2014; 134;e1282. doi: 10.1542/peds.2014-2111A.
230. WHO/UNIFEC. Researching optimal iodine nutrition in pregnant and lactating women and young children. Geneva, Switzerland: World Health Organization, 2007. doi: 10.1017/S1368980007361004.
231. Becker, D. V., et al. Iodine supplementation for pregnancy and lactation, United States and Canada: Recommendations from the American Thyroid Association. *Thyroid*. 2006 Oct 16; (10):959–951.
232. Caldwell, K. L., et al. Urinary iodine concentration: United States National Health and Nutrition Examination Survey 2001–2002. *Thyroid*. 2005; 15:692–699.
233. Duley, L., et al. Altered dietary salt for preventing preeclampsia, and its complications. *Cochrane Database of Syst Rev.* 2005; 4: Art. No. CD005548. doi: 10.1002/14651858.CD005548.
234. Mistry, H. D., et al. The importance of antioxidant micronutrients in pregnancy. *Oxid Med Cell Longev*. 2011; 841749.

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References

235. Litonjua, A. A., et al. Maternal antioxidant intake in pregnancy and wheezing illnesses in children at 2 y of age. *Am J Clin Nutr.* 2006; 84:903–911.
236. Devereux, G., et al. Low intake of vitamin E during pregnancy may increase risk for childhood asthma. *Am J Respir Grit Care Med.* 2006; 174:499–507.
237. Menezes, F. P., et al. Chapter 22—Caffeine. *Repro Developmental Toxicol,* 2nd ed. 2017; 399–411.
238. Mitchell, D. C., et al. Beverage caffeine intakes in the U.S. *Food Chem Toxicol.* 2014; 63:136–142.
239. Bakker, R., et al. Maternal caffeine intake from coffee and tea, fetal growth, and the risks of adverse birth outcomes: The Generation R Study. *Am J Clin Nutr.* 2010; 91:1691–1698.
240. Pittman, G. Some caffeine okay during pregnancy: Obstetricians. Released July 21, 2010. Available at www.medscape.com /viewarticle/725562, accessed July 27, 2010.
241. Modaelewska D., et al. Caffeine Exposure during pregnancy, small for gestational age birth and neonatal outcome. Available at https://bmcpregnancychildbirth .biomedcentral.com/articles/10.1186/s12884 -019-2215-9. Published February 26, 2019.
242. Jahanfar, S., et al. Effects of restricted caffeine intake by mother on fetal, neonatal and pregnancy outcome. *Cochrane Database Syst Rev.* 2009; 15:CD006965.
243. Brent, R. L., et al. Evaluation of the reproductive and developmental risks of caffeine. *Birth Defects Res B Dev Reprod Toxicol.* 2011; 92:152–187.
244. Pittman, G. Some caffeine okay during pregnancy: Obstetricians. Released July 21, 2010. Available at www.medscape.com/ viewarticle/725562, accessed July 27, 2010.
245. Ershow, A. G., et al. Intake of tapwater and total water by pregnant and lactating women. *Am J Public Health.* 1991; 81:328–834.
246. Hook, E. B. Dietary cravings and aversions during pregnancy. *Am J Clin Nutr.* 1978; 31:1355–1362.
247. Brown, J. E., et al. Taste changes during pregnancy. *Am J Clin Nutr.* 1986; 43:412–416.
248. The metallic taste in your mouth during pregnancy. Reviewed October 2018. Available at https://www.healthline.com /health/pregnancy/metallic-taste-in-mouth, accessed April 8, 2023.
249. Johns, T., et al. Detoxification and mineral supplementation as functions of geophagy. *Am J Clin Nutr.* 1991; 53:448–456.
250. Brent, R. L., et al. Evaluation of the reproductive and developmental risks of caffeine. *Birth Defects Res B Dev Reprod Toxicol.* 2011; 92:152–187.
251. Rainville, A. J. Pica practices of pregnant women are associated with lower maternal hemoglobin level at delivery. *J Amer Diet Assoc.* 1998; 98:293–296.
252. Koutelidakis, A. E., et al. Higher adherence to Mediterranean diet prior to pregnancy is associated with decreased risk for deviation from the maternal recommended gestational weight gain. *Int J Food Sci Nutr.* June 14, 2017. doi: doi.org/10.1080/09637486.201 7.1330403.
253. Gomez-Arango, L. F., et al. Low dietary fiber intake increases *Collinsella* abundance in the gut microbiota of overweight and obese pregnant women. *Gut Microbes.* 2018; 9(3):189–201. doi: doi.org/10.1080 /19490976.2017.1406584.
254. Tabung, F. K., et al. An empirical dietary inflammatory pattern score enhances prediction of circulating inflammatory biomarkers in adults. *J Nutr.* 2017; 147:1567–1577.
255. Hylton, J. Prenatal Nutrition. April 2, 2018. Available at emedicine.medscape.com /article/259059overview#aw2aab6b2, accessed April 8, 2023.
256. Snow, D. Vegetarian diet during pregnancy: Making sure vitamin B_{12} intake is adequate. *MCH Nurs.* 2018; 43:18.
257. Position of the American Dietetic Association and Dietitians of Canada: Vegetarian diets. *J Am Diet Assoc.* 2003; 103:748–765.
258. Leitzman, C. Vegetarian nutrition: Past, present, future. *Am J Clin Nutr.* 2014; 100(suppl):496–502S.
259. Burdge, G. C., et al. Long-chain n-3 PUFA in vegetarian women: A metabolic perspective. *J Nutr Sci.* 2017 Nov 23; 6:e58. doi: doi.org/10.1017/ jns.2017.62245.
260. White, N. D. Lifestyle and complementary medicine for common gastrointestinal disorders in pregnancy. *J Lifestyle Med.* 2014; 8:97–99.
261. Balbontín, M., et al. Herbal Medicinal Product Use During Pregnancy and the Postnatal Period: A Systematic Review. *Obstet Gynecol.* 2019; 133(5):920–932. doi: 10.1097/AOG.0000000000003217.
262. Dog, L. T. The use of botanicals during pregnancy and lactation. *Altern Ther Health Med.* 2009; 15:54–58.
263. Marcus, D. M. Do no harm: Avoidance of herbal medicines during pregnancy. *Obstet Gynecol.* 2005; 105(5 Pt. 1):1119–1122.
264. FDA statement concerning structure/ function rule and pregnancy claims. HHS Statement, U.S. Department of Health and Human Services; 65 FR 1000; January 6, 2000; Docket No. 98N-0044.
265. Meisler, J. G. Toward optimal health: The experts discuss the use of botanicals by women. *J Women's Health.* 2003; 12:847–852.
266. Jones, F. A. Herbs: Useful plants. *J R Soc Med.* 1996; 89:717–719.
267. Dugoua, J. J., et al. Safety and efficacy of ginkgo (*Ginkgo biloba*) during pregnancy and lactation. *Can J Clin Pharmacol.* 2006; 13:e277–e284. Published November 3, 2006.
268. Vutyavanich, T., et al. Ginger for nausea and vomiting in pregnancy: Randomized, double-masked, placebo-controlled trial. *Obstet Gynecol.* 2001; 97:577–582.
269. Food safety for pregnant women. Available at https://www.foodsafety.gov/people-at -risk/pregnant-women. Published September 25, 2020.
270. *Summary of the Nutrition Care Process Steps for Nutrition Assessment* Pocket Guide for International Dietetics & Nutrition Terminology Reference Manual, 2nd ed. (Chicago: American Dietetic Association, 2009).
271. Nutrition Assessment Snapshot. NCP Step 1: Nutrition Assessment. Available at https://www.ncpro.org/nutrition-assessment -snapshot, accessed April 8, 2023.
272. Larsson, A., et al. Reference values for clinical chemistry tests during normal pregnancy. *BJOG.* 2008; 115:874–881.
273. Garland, M. Physical activity during pregnancy: A prescription for improved perinatal outcomes. *J Nurse Pract.* 2017; 13:54–58. *Obstet Gynecol Scand.* 2017; 96:362–373.
274. Magro-Malosso, E. R., et al. Exercise during pregnancy and risk of preterm birth in overweight and obese women: A systematic review and meta-analysis of randomized controlled trials. *Acta Obstet Gynecol Scand.* 2017; 96:362–373.
275. Keller, J., Frederking, D., & Layer, P. The spectrum and treatment of gastrointestinal disorders during pregnancy. *Nat Clin Pract Gastroenterol Hepatol.* 2008 Aug; 5(8):430–443. doi: 10.1038/ncpgasthep 1197. PMID: 18670442.
276. ACOG Practice Bulletin No. 189. Nausea and vomiting of pregnancy. *Obstet Gynecol.* 2018; 131(1):e15–e30. doi: 10.1097 /AOG.0000000000002456.
277. White, N. D. Lifestyle and complementary medicine for common gastrointestinal disorders in pregnancy. *J Lifestyle Med.* 2014; 8:97–99.
278. Badell, M. L., et al. Treatment options for nausea and vomiting during pregnancy. *Pharmacotherapy.* 2006; 26:1273–1287.
279. Cogswell, M. E., et al. Iron supplement use among women in the United States: Science, policy, and practice. *J Nutr.* 2003; 133:1974S–1977S.
280. Badell, M. L., et al. Treatment options for nausea and vomiting during pregnancy. *Pharmacotherapy.* 2006; 26:1273–1287.
281. Meinich T., et al. Early maternal weight gain as a risk factor for SGA in pregnancies with hyperemesis gravidarum. Available at https:// bmcpregnancychildbirth.biomedcentral .com/articles/10.1186/s12884-020-02947-3. Published April 28, 2020.
282. Rapaport, L. More evidence common morning sickness drug may not work. *Medscape.* January 18, 2018. Available at www.reuters .com, accessed February 12, 2023.
283. Phelan, S., et al. Effect of an Internet-based program on weight loss for low-income postpartum women: A randomized clinical trial. *JAMA.* 2017; 317(23):2381–2391. doi: 10.1001/jama.2017.7119.
284. USDA finalizes changes to the WIC program, expanding access to healthy fruits and vegetables, whole grains, and low-fat dairy for women, infants, and children. Available at www.fns.usda.gov/pressrelease/2014/003114, accessed April 8, 2023.
285. Allen, L. H. Multiple micronutrients in pregnancy and lactation: An overview. *Am J Clin Nutr.* 2005; 81:1206S–1212S.

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References

Chapter 5

1. Chu, S. Y., et al. Association between obesity during pregnancy and increased use of health care. *N Engl J Med*. 2008; 358:1444–1453.
2. Riley, L., Wertz, M., and McDowell, I. Obesity in pregnancy: Risks and management. *Am Fam Physician*. 2018; 97(9):559–561.
3. Riley, L., Wertz, M., and McDowell, I. Obesity in pregnancy: Risks and management. *Am Fam Physician*. 2018; 97(9):559–561.
4. Krakoff, L. R. Adiposity and risk for hypertension: Does location matter? *J Am Coll Cardiol*. 2014; 64:1003–1004.
5. Heerwagen, M. J. R., et al. Maternal obesity and fetal metabolic programming: A fertile epigenetic soil. *Am J Physiol Regul Integr Comp Physiol*. 2010; 299:R711–R722.
6. Godfrey, K. M., et al. Influence of maternal obesity on the long-term health of offspring. *Lancet Diabetes Endocrinol*. 2017; 5:53–64.
7. Ma, R. C., et al. Clinical management of pregnancy in the obese mother: Before conception, during pregnancy, and post-partum. *Lancet Diabetes Endocrinol*. 2016; 4:1037–1049.
8. Feng, R. How much do we know about the heritability of obesity? *Am J Clin Nutr*. 2016; 104:243–244.
9. Karpe, F., et al. Obesity—On or off? *N Engl J Med*. 2016; 374:1486–1488.
10. Ozanne, S. E., et al. Epigenetic signatures of obesity. *N Engl J Med*. 2015; 372:973–974.
11. Catalano, P. M., & Shankar, K. Obesity and pregnancy: Mechanisms of short term and long term adverse consequences for mother and child. *BMJ Clin Res*. 2017; 356:j1.
12. Richmond, R. C., et al. Using genetic variation to explore the causal effect of maternal pregnancy adiposity on future offspring adiposity: A Mendelian randomisation study. *PLoS*. Published January 24, 2017. doi: dx.doi.org/10.1371/journal.pmed.1002221.
13. Ma, D., et al. Association between gestational weight gain according to prepregnancy body mass index and short postpartum weight retention in postpartum women. *Clin Nutr*. 2014 Apr; 34(2). doi: 10.1016/j.clnu.2014.04.010.
14. Obstetrics & Gynecology: Committee Opinion Number 763 (replaces Committee Opinion Number 600, June 2014). Available at https://www.acog.org/clinical/clinical-guidance/committee-opinion/articles/2019/01/ethical-considerations-for-the-care-of-patients-with-obesity. Published December 20, 2018.
15. Vesco, K. K., et al. Efficacy of a group-based dietary intervention for limiting gestational weight gain among obese women: A randomized trial. *Obesity* (Silver Spring). 2014; 22:989–996.
16. Nainggolan, L. Intervene early in pregnancy to limit weight gain in obese. June 21, 2014. Joint Meeting of the International Society of Endocrinology and the Endocrine Society: ICE/ENDO 2014. Available at www.medscape.com/viewarticle/827170.
17. Bloomberg, M., et al. Maternal and neonatal outcomes among obese women with weight gain below the New Institute of Medicine recommendations. *Obstet Gynecol*. 2011; 117:1065–1070.
18. Rasmussen, K. M., et al. Recommendations for weight gain during pregnancy in the context of the obesity epidemic. *Obstet Gynecol*. 2010; 116:1191–1195.
19. Schummers, L., et al. Risk of adverse pregnancy outcomes by prepregnancy body mass index: A population-based study to inform prepregnancy weight loss counseling. *Obstet Gynecol*. 2015 Jan; 125(1):133–143. doi: 10.1097/AOG.0000000000000591. PMID: 25560115; PMCID: PMC4285688.
20. King, J. C. A summary of pathways or mechanisms linking preconception maternal nutrition with birth outcomes. *J Nutr*. 2016; 146(suppl):1437S–1444S.
21. Maggard, M. A., et al. Pregnancy and fertility following bariatric surgery: A systematic review. *JAMA*. 2008; 300:2286–2296.
22. Alatishe, A., et al. Bariatric surgery in women of childbearing age. *QJM: An Intern J Med*. 2013 Aug; 106(8):717–720. doi: https://doi.org/10.1093/qjmed/hct081.
23. Kaplan, L. M. What bariatric surgery can teach us about endoluminal treatment of obesity and metabolic disorders. *Gastrointest Endosc Clin N Am*. 2017; 27:213–231. doi: 10.1016/j.giec.2017.01.004.
24. Giusti, V., et al. Energy and macronutrient intake after gastric bypass for morbid obesity: A 3-y observational study focused on protein consumption. *Am J Clin Nutr*. 2016; 103:18–24.
25. Schauer, P. R., et al. Bariatric surgery versus intensive medical therapy for diabetes—5-year outcomes. *N Engl J Med*. 2017; 376:641–651.
26. Johnson, D. A. Tips for monitoring post-bariatric surgery nutritional deficiencies. *Medscape*. 2017. Available at www.medscape/com/viewarticle/875462.
27. Agrawal, S. Understanding both metabolic and bariatric surgery. March 2020. Available at https://www.topdoctors.uk/medical-articles/understanding-both-metabolic-and-bariatric-surgery, accessed April 11, 2023.
28. Gentileschi, P., et al. Metabolic surgery for type II diabetes: An update. *Acta Diabetol*. 2021; 58:1153–1159. doi: https://doi.org/10.1007/s00592-021-01722-w.
29. Parent, B., et al. Bariatric surgery in women of childbearing age, timing between an operation and birth, and associated perinatal complications. *JAMA Surg*. 2017; 152(2):1–8.
30. Johansson, K., et al. Outcomes of pregnancy after bariatric surgery. *N Engl J Med*. 2015; 372:814–824.
31. Malinowski, S. S. Nutritional and metabolic complications of bariatric surgery. *Am J Med Sci*. 2006; 331:219–225.
32. Kominiarek, M. A., et al. Guidelines on managing obesity in pregnancy. American College of Obstetrics and Gynecology. *Obstet Gynecol*. 2009; 113:1405–1413.
33. Metabolic and bariatric surgery. July 2021. Available at https://www.asmbs.org/app/uploads/2021/07/Metabolic-Bariac-surgery-fact-sheet-2021/pdf.
34. Umesawa, M., et al. Epidemiology of hypertensive disorders in pregnancy: Prevalence, risk factors, predictors and prognosis. *Hypertension Res*. 2017; 40:213–220.
35. Barton, J. R., et al. Biomarkers for prediction, risk stratification, and ruling out preeclampsia. *Am J Perinatol*. 2017; 34:415–418.
36. Benschop, L., Duvekot, J. J., & Roeters van Lennep, J. E. Future risk of cardiovascular disease risk factors and events in women after a hypertensive disorder of pregnancy. *Heart*. 2019; 105:1273–1278.
37. Mayo Clinic: Preeclampsia. Available at https://www.mayoclinic.org/diseases-conditions/preeclampsia/symptoms-causes/syc-20355745. Published March 19, 2020.
38. Giannakou, K., et al. Genetic and non-genetic risk factors for pre-eclampsia: An umbrella review of systematic reviews and meta-analyses of observational studies. *Ultrasound Obstet Gynecol*. 2017. doi: doi.org/10.1002/uog.18959.
39. Timpkka, S., et al. Lifestyle in progression from hypertensive disorders of pregnancy to chronic hypertension in Nurses' Health Study II: Observational cohort study. *BMJ*. 2017; 358:j3024.
40. Foods that fight inflammation. *Harvard Women's Health Watch*. 2017. Available at www.health.harvard.edu/staying-healthy/foods-that-fight-inflammation.
41. Tranquilli, A. L. Introduction to ISSHP new classification of preeclampsia. *Pregnancy Hypertens*. 2013; 3(2):58–59.
42. US Preventive Services Task Force. Screening for preeclampsia: US Preventive Services Task Force Recommendation Statement. *JAMA*. 2017; 317:1661–1667.
43. Luger, R. K., & Kight, B. P. Hypertension in Pregnancy. Updated 2022 Oct 3. *StatPearls*. Treasure Island, FL: StatPearls Publishing.
44. Moussa, H. N., et al. Management of hypertensive disorders in pregnancy: Definitions & classifications. *Womens Health (Lond)*. 20 July; 10(4):385–404. CME Released September 26, 2014. Available at www.medscape.org/viewarticle/831994.
45. Rodriguez-Lopez, M., et al. Revisiting the discriminatory accuracy of traditional risk factors in preeclampsia screening. *PLoS ONE*. 2017 May; 12(5):e0178528. doi: doi.org/10.1371/journal.pone.0178528.
46. Lambert, G., et al. Preeclampsia: An update. *Acta Anaesthesiol Belg*. 2014; 65:137–149.

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References

47. Goldstein, R. F., et al. Association of gestational weight gain with maternal and infant outcomes. A systematic review and meta-analysis. *JAMA*. 2017; 317:2207–2225.
48. Rumbold, A. R., et al. ACTS Study Group. Vitamins C and E and the risks of preeclampsia and perinatal complications. *N Engl J Med*. 2006 April 27; 354(17):1796–806.
49. Zhou, S. J., et al. Fish-oil supplementation in pregnancy does not reduce the risk of gestational diabetes or preeclampsia. *Am J Clin Nutr*. 2012; 95:1378–1384.
50. Rumbold, A., et al. Antioxidants for preventing preeclampsia. *Chochrane Database Syst Rev*. 2008; 23(1):CD004227.
51. O'Callaghan, K. M., & Kiely, M. Systematic review of vitamin D and hypertensive disorders of pregnancy. *Nutrients*. 2018 Mar 1; 10(3):294.
52. Gomes F, et al. Calcium supplementation for the prevention of hypertensive disorders of pregnancy: current evidence and programmatic considerations. *Ann NY Acad Sci*. 2022 Apr; 1510(1):52–67.
53. Ng, S. W., Norwitz, S. G., & Norwitz, E. R. The impact of iron overload and ferroptosis on reproductive disorders in humans: implications for preeclampsia. *Intern J Molec Sci*. 2019 Jul 4; 20(13):3283.
54. Classification and diagnosis of diabetes. American Diabetes Association. *Diabetes Care*. 2017 Jan; 40(Suppl 1):S11–S24.
55. 2011 National Diabetes Fact Sheet. Available at www.cdc.gov/diabetes/pubs/factsheet11.htm, accessed April 10, 2023.
56. Gestational Diabetes. December 2022. Available at https://www.cdc.gov/diabetes/basics/gestational.html, accessed April, 10, 2023.
57. Relph, S. et al. Adverse pregnancy outcomes in women with diabetes-related microvascular disease and risks of disease progression in pregnancy. Available at https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003856. Published November 22, 2021.
58. American Diabetes Association. Management of diabetes in pregnancy: Standards of medical care in diabetes—2018. *Diabetes Care*. 2018 Jan; 41(Suppl 1):S137–S143.
59. American Diabetes Association Professional Practice Committee; 15. Management of Diabetes in Pregnancy: *Standards of Medical Care in Diabetes—2022*. *Diabetes Care*. 2022 Jan 1; 45 (Suppl 1):S232–S243. doi: https://doi.org/10.2337/dc22-S015.
60. Hansen, N. S., et al. Fetal hyperglycemia changes human preadipocyte function in adult life. *JCEM*. 2017; 102(4):1141–1150. doi: doi.org/10.1210/jc.2016-3907. Published February 13, 2017.
61. Pettitt, D. J., et al. *In utero* exposure to diabetes and type 2 diabetes risk later in life. *Diabetes Care*. 2008; 31:2126–2130.
62. Dabelea, D., Knowler, W. C., & Pettitt, D. J. Effect of diabetes in pregnancy on offspring: Follow-up research in the Pima Indians. *J Maternal Fetal Med*. 2000 Jan; 9(1):83–88.
63. MacNeill, S., et al. Rates and risk factors for recurrence of gestational diabetes. *Diabetes Care*. 2001; 24:659–662.
64. McIntyre, H. D., Catalano, P., Zhang, C., Desoye, G., Mathiesen, E. R., & Damm, P. Gestational diabetes mellitus. *Nature Reviews Disease Primers*. 2019 Jul 11; 5(1):47.
65. Kitzmiller, J. L., et al. Managing preexisting diabetes for pregnancy. *Diabetes Care*. 2008; 31:1060–1079.
66. Hopkins, S. A., et al. The role of exercise in reducing the risks of gestational diabetes mellitus. *Women's Health*. 2013; 9:569–581.
67. Xiao, R. S., et al. Diet quality and history of gestational diabetes mellitus among child-bearing women, United States, 2007–2010. *Prev Chronic Dis*. 2015 Feb 26; 12:E25 Available at www.medscape.com/viewarticle/840902?nlid.
68. Bodnar, L. M., et al. Periconceptional multivitamin use reduces the risk of preeclampsia. *Am J Epidemiol*. 2006; 164:470–477.
69. Catov, J. M., et al. Association of periconceptional multivitamin use with reduced risk of preeclampsia among normal-weight women in the Danish National Birth Cohort. *Am J Epidemiol*. 2009; 169:1304–1311.
70. Shin, D., et al. Dietary patterns during pregnancy are associated with risk of gestational diabetes mellitus. *Nutrients*. 2015; 12(7):9369–9382.
71. Schoenaker, D. A., et al. The role of energy, nutrients, foods, and dietary patterns in the development of gestational diabetes mellitus: A systematic review of observational studies. *Diabetes Care*. 2016 Jan; 39(1):16–23.
72. Tobias, D. K., et al. Prepregnancy adherence to dietary patterns and lower risk of gestational diabetes mellitus. *Am J Clin Nutr*. 2012; 96:289–295.
73. Maki, K. C., et al. Replacement of refined starches and added sugars with egg protein and unsaturated fats increases insulin sensitivity and lowers triglycerides in overweight or obese adults with elevated triglycerides. *J Nutr*. 2017; 147:1267–1274.
74. Zhang, C., et al. Risk factors for gestational diabetes: Is it preventable. Available at https://link.springer.com/article/10.1007/s00125-016-3979-3. Published May 10, 2016.
75. Adams, K. M., et al. Sequelae of unrecognized gestational diabetes. *Am J Obstet Gynecol*. 1998; 178:1321–1332.
76. Coad, S., et al. Understanding urinalysis, clues for the obstetrician-gynecologist. *Expert Rev of Obstet Gynecol*. 2012; 7:269–279.
77. Miao, M., et al. Influence of maternal overweight, obesity and gestational weight gain on the perinatal outcomes in women with gestational diabetes mellitus. *Sci Rep*. 2017 Mar 22; 7(1):305. doi: 10.1038/s41598-017-00441-z.
78. Wang, G., et al. Hypertension associated expenditures for medication among US adults. *Am J Hypertens*. 2013; 26:423–425.
79. Song, C., et al. Lifestyle intervention can reduce the risk of gestational diabetes: A meta-analysis of randomized controlled trials. *Obesity Rev*. 2016; 17:960–969.
80. Wickens, K. L., et al. Early pregnancy probiotic supplementation with Lactobacillus rhamnosus HN001 may reduce the prevalence of gestational diabetes mellitus: A randomised controlled trial. *Br J Nutr*. 2017; 117:804–813.
81. Reader, D. M. Medical nutrition therapy and lifestyle interventions. *Diabetes Care*. 2007; 30(Suppl 2):S188–S193.
82. de Barros, M. C., et al. Resistance exercise and glycemic control in women with gestational diabetes mellitus. *Am J Obstet Gynecol*. 2010; 203:556.e1–556.e6.
83. Evert, A. B., et al. Nutrition therapy recommendations for the management of adults with diabetes. *Diabetes Care*. 2013 Oct 9. doi: 10.2337/dc13-2042, accessed July 21, 2014.
84. Gray, A., et al. Nutritional Recommendations for Individuals with Diabetes. Available at https://www.ncbi.nlm.nih.gov/books/NBK279012/. Last Updated October 13, 2019.
85. Astrup, A., et al. The role of higher protein diets in weight control and obesity-related comorbidities. *Int J Obes*. 2015; 39:721–726.
86. ter Braak, E. W. M., et al. Maternal hypoglycemia during pregnancy in type 1 diabetes: Maternal and fetal consequences. *Diab Metab Res Rev*. 2002; 18:96–105.
87. Schenk, S., Andrey, M., Vuignier, Y, & Puder, J. J. Impact métabolique des fibres en cas de diabète gestationne [The metabolic impact of fiber in gestational diabetes]. *Rev Med Suisse*. 2022 Jun 1; 18(784):1096–1099. French. doi: 10.53738/REVMED.2022.18.784.1096. PMID: 35647746.
88. Butte, N. F. Dieting and exercise in overweight, lactating women. *N Engl J Med*. 2000 Feb 17; 342(7):502–503.
89. Bao, W., et al. Physical activity and sedentary behaviors associated with risk of progression from gestational diabetes mellitus to type 2 diabetes mellitus: A prospective cohort study. *JAMA Intern Med*. 2014 Jul 1; 174(7):1047–1055.
90. Dennison, R. A., et al. Women's views on lifestyle changes to reduce the risk of developing type 2 diabetes after gestational diabetes: a systematic review, qualitative synthesis and recommendations for practice. *Diab Med*. 2019 Jun; 36(6):702–717.
91. Gestational diabetes. 2017 May. Available at www.diabetes.niddk.nih.gov/health-information/diabetes/overview/what-is-diabetes/gestational/all-content, accessed April 12, 2023.
92. Kalkwarf, H. J., et al. Dietary fiber intakes and insulin requirements in pregnant women with type 1 diabetes. *J Am Diet Assoc*. 2001; 101:305–310.
93. Farrington, C., et al. Experiences of closed-loop insulin delivery among pregnant women with Type 1 diabetes. *Diab Med*. 2017. doi: doi.org/10.1111/dme.13406.

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References

94. Martin, J. A., & Osterman, M. J. K. Is twin childbearing on the decline? Twin births in the United States, 2014–2018. NCHS Data Brief, No. 351. Hyattsville, MD: National Center for Health Statistics. 2019. Available at https://www.cdc.gov/nchs/products/databriefs/db351.htm.
95. Osterman, M. J. K., et al. Births: Final Data for 2021. *Natl Vital Stat Report 2021*. 2023 Jan; 72(1). Available at https://stacks.cdc.gov/view/cdc/122047.
96. Broughton, D. E., et al. ES. 7-Multiple gestations and assisted reproductive technology. *Avery's Diseases of the Newborn*, 2018; 1070–1077.e4, 10th ed. doi: doi.org/10.1016/B978-0-323-40139-5.00007-3.
97. Brown, J. E., & Schloesser, P. T. Prepregnancy weight status, prenatal weight gain, and the outcome of term twin gestations. *Ame J Obstet Gynecol*. 1990 Jan 1; 162(1):182–186.
98. Vaajala, M., et al. Obesity increases the odds of multiple pregnancies: A nationwide register-based cohort study in Finland. *Intern J Gynecol & Obstet*. 2023 Mar 14. doi: 10.1002/ijgo.14748.
99. Wojas, A., et al. Correlation between clinical chorionicity and SNP-based CfDNA zygosity assignment in #8,808 twin pregnancy. Available at https://www.thieme-connect.com/products/ejournals/abstract/10.1055/s-0041-1735770. Published 2021.
100. Web MD Editorial Contributors. Types of Twins: What to Know. Reviewed by D. Brennan, August 2022. Available at https://www.webmd.com/baby/what-are-dizygotic-twins, accessed April 11, 2023.
101. Redline, R. W. Non-identical twins with a single placenta—Disproving dogma in perinatal pathology. *N Engl J Med*. 2003; 349:111–114.
102. Imaizumi, Y. A comparative study of twinning and triplet rates in 17 countries, 1971–1996. *Acta Genet Med Gemellol*. 1998; 47:101–114.
103. Czeizel, A. E., et al. Higher rate of multiple births after periconceptional vitamin supplementation. *N Engl J Med*. 1994; 330:1687–1688.
104. Types of Twins. Available at https://www/twins.org.au/research/twin-and-data-resource/76-types-of-twins, accessed April 11, 2023.
105. Ellings, J. M., et al. Reduction in very low birth weight deliveries and perinatal mortality in a specialized, multidisciplinary twin clinic. *Obstet Gynecol*. 1993; 81:387–391.
106. Evron, E., et al. Vanishing twin syndrome: Is it associated with adverse perinatal outcome? *Fertil Steril*. 2015 May 1; 103(5):1209–1214.
107. Haynes, A. J., et al. Triplet pregnancy. Up to date, 2017. Available at www.uptodate.com/contents/triplet-pregnancy.
108. Martin J., et al. National Vital Statistics Report: Births: Final Data for 2019. March 23, 2021. Available at https://www.cdc.gov/nchs/data/nvsr/nvsr70/nvsr70-02-508.pdf.
109. Brown, J. E., et al. Prepregnancy weight status, prenatal weight gain, and the outcome of term twin gestations. *Am J Obst Gynecol*. 1990; 162:182–186.
110. Weight Gain in Pregnancy. ACOG Committee on Obstetric Practice. 2013 Jan; 548. Reaffirmed 2020. Available at https://www.acog.org/clinical/clinical-guidence/committee-opnion/articles/2013/01/weight-gain-in-pregnancy, accessed April 12, 2023.
111. Kulkarni, A. D., et al. Fertility treatments and multiple births in the United States. *N Engl J Med*. 2013; 369:22118–22125.
112. Ellings, J. M., et al. Reduction in very low birth weight deliveries and perinatal mortality in a specialized, multidisciplinary twin clinic. *Obstet Gynecol*. 1993; 81:387–391.
113. Dubois, S., et al. Twin pregnancy: The impact of the Higgins Nutrition Intervention Program on maternal and neonatal outcomes. *Am J Clin Nutr*. 1991; 53:1397–1403.
114. National Academy of Sciences. *Nutrition During Pregnancy. I. Weight Gain. II. Nutrient Supplements*. Washington, DC: National Academy Press, 1990.
115. Institute of Medicine and National Research Council. *Guidelines on Weight Gain and Pregnancy*. Washington, DC: The National Academies Press, 2013. doi: https://doi.org/10.17226/18291.
116. Rassmussen, K. M., et al. Weight gain during pregnancy: Reexamining the guidelines. Institute of Medicine, 2009. Available at www.nap.nationalacademies.org/catalog/18291/guidelines-on-weight-gain-and-pregnancy, accessed April 12, 2023.
117. Greenan, C. W., et al. Achievement of body mass index specify weight gain recommendations. *Am J Perinatol*. 2017; 34:1293–1301.
118. Brown, J. E., et al. Nutrition and multifetal pregnancy. *J Am Diet Assoc*. 2000; 100:343–348.
119. Institute of Medicine and National Research Council. *Guidelines on Washington, DC: The National Academies Press, 2013*. doi: https://doi.org/10.17226/18291.
120. Konwinski, T., et al. Maternal pregestational weight and multiple pregnancy duration. *Acta Genet Med Gemellol*. 1973; 22:44–47.
121. Position of the Academy of Nutrition and Dietetics: Nutrition and Lifestyle for a Healthy Pregnancy Outcome. *J Acad Nutr Diet*. 2014; 114:1099–1103.
122. Tabler, J., et al. Variation in reproductive outcomes of women with histories of bulimia nervosa, anorexia nervosa, or eating disorder not otherwise specified relative to the general population and closest-aged sisters. *Int J Eat Disord*. 2018; 51(2):102–111.
123. Morrill, E. S., et al. Bulimia nervosa during pregnancy: A review. *J Am Diet Assoc*. 2001; 102:448–454.
124. Easter, A., et al. Recognising the symptoms: How common are eating disorders in pregnancy? *Euro Eat Disord Rev*. 2013 Jul; 21(4):340–344.
125. Madowitz, J., Matheson, B. E., & Liang, J. The relationship between eating disorders and sexual trauma. Eating and weight disorders—Studies on anorexia, bulimia and obesity. *Eat Weight Discord*. 2015 Sep; 20:281–293.
126. Hoffman, E. R., et al. Reproductive issues in anorexia nervosa. *Expert Rev of Obstet Gynecol*. 2011; 6:403–414.
127. Little, L., et al. Midwifery. Love of women with eating disorders. *Women's Health* 2000; 45:301–307.
128. Arnold C., et al. The effects of eating disorders in pregnancy on mother and baby: A review. *Psychiatria Danubina*. 2019 Sep 4; 31(suppl 3):615–618.
129. Watson, H., et al. Maternal eating disorders and perinatal outcomes: A three-generation study in the Norwegian Mother and Child Cohort Study. *J Abnormal Psychol*. 2017; 126:552–564.
130. Linderg, S. Could you be experiencing "pregorexia"? Here's how to break the cycle. *Healthline*, September 2020. Available at https://www.healthline.com/health/pregnancy/pregorexia.
131. Feldman, H. S., et al. Prenatal alcohol exposure patterns and alcohol-related birth defects and growth deficiencies: A prospective study. *Alcohol Clin Exp Res*. 2012; 36:670-676. doi: 10.1111/j.1530–0277.2011.01664.x.
132. Van Heertum, K., et al. Alcohol and fertility: How much is too much? *Fertil Res Pract*. 2017; 3:10. doi: 10.1186/s40738-017-0037-x.
133. May, P. A., et al. Prevalence of fetal alcohol spectrum disorders in 4 US communities. *JAMA*. 2018; 319:474–482, 448–449.
134. Hoyme, H. E., et al. Updated clinical guidelines for diagnosing fetal alcohol spectrum disorders. *Pediatrics*. 2016; 138:e20154256.
135. Popova, S., et al. Estimation of national, regional, and global prevalence of alcohol use during pregnancy and fetal alcohol syndrome: A systematic review and meta-analysis. *Lancet Global Health*. 2017; 5:e290–e299.
136. Bower, C., et al. New opportunities for evidence in fetal alcohol spectrum disorder. *JAMA Pediatr*. doi: 10.1001/jamapediatrics.2017.1342. Published June 5, 2017.
137. Leftwich, H. K., et al. Adolescent pregnancy. *Pediatr Clin*. 2017; 64:381–388.
138. Lassi, Z. S., et al. Review of nutrition guidelines relevant for adolescents in low- and middle-income countries. *Ann NY Acad Sci*. 2017. doi: doi.org/10.1111/nyas.13332.
139. Krebs, N., et al. International summit on the nutrition of adolescent girls and young women: Consensus statement. *Ann NY Acad Sci*. 2017. doi: doi.org/10.1111/nyas.13417.
140. Scholl, T. O., et al. Maternal growth during pregnancy and the competition for nutrients. *Am J Clin Nutr*. 1994; 60:183–188.
141. Kawakita, T., et al. Adverse maternal and neonatal outcomes in adolescent pregnancy. *J Ped Adoles Gynecol*. 2016; 29:130–136.

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Editorial review has deemed that any suppressed content does not materially affect the overall learning experience. Cengage Learning reserves the right to remove additional content at any time if subsequent rights restrictions require it.

References

142. Gilbert, W., et al. Birth outcomes in teenage pregnancies. *J Mat Fetal Neonat Med*. 2004; 16:265–270.
143. Sukalich, S., Mingione, M. J., & Glantz, J. C. Obstetric outcomes in overweight and obese adolescents. *Am J Obstet Gynecol*. 2006 Sep 1; 195(3):851–855.
144. Haeri, S., et al. The effect of teenage maternal obesity on perinatal outcomes. *Obstet Gynecol*. 2009 Feb 1; 113(2 Part 1):300–304.
145. Young, B. E., et al. Maternal vitamin D status and calcium intake interact to affect fetal skeletal growth *in utero* in pregnant adolescents. *Am J Clin Nutr*. 2012; 95:1103–1112.
146. Nielsen, J. N., et al. Interventions to improve diet and weight gain among pregnancy adolescents and recommendations for future research. *J Am Diet Assoc*. 2006; 106:1825–1840.
147. Wastnedge, E. A, et al. Pregnancy and COVID-19. *Physiol Rev*. 2021 Jan 1; 101(1):303–318.
148. Ackerman, C. M., et al. Clinical and pregnancy outcomes of coronavirus disease 2019 among hospitalized pregnant women in the United States. In *Open Forum Infectious Diseases* (Vol. 9, No. 2, p. ofab429). The United States: Oxford University Press, 2022.
149. Stock, S. J., et al. SARS-CoV-2 infection and COVID-19 vaccination rates in pregnant women in Scotland. *Nat Med*. 2022 Mar; 28(3):504–512. doi: https://doi.org/10.1038/s41591-021-01666-2.

Chapter 6

1. Bartick, M., et al. Academy of Breastfeeding Medicine Position Statement and Guideline: Infant Feeding and Lactation-Related Language and Gender. *Breastfeed Med*. 2021; 16(8) DOI: 10.1089/bfm.2021.29188.abm.
2. Centers for Disease and Prevention. Breastfeeding Report Card 2020. Available at http://www.cdc.gov/breastfeeding/data/facts.html, accessed March 2022.
3. Lawrence, R. A., et al. *Breastfeeding: A Guide for the Medical Professional*, 9th ed. Minneapolis, MN: Mosby, 2021.
4. Wombach, K. & Spencer, B. *Breastfeeding and Human Lactation,* 6th ed. Burlington, MA: Jones & Bartlett Learning, 2021.
5. Hartmann, P. E. Changes in the composition and yield of the mammary secretion of cows during the initiation of lactation. *J Endocrinol*. 1973; 59(2):231–247.
6. Brownell, E., et al. Delayed onset lactogenesis II predicts the cessation of any or exclusive breastfeeding. *J Pediatr*. 2012; 161(4):608–614.
7. Kim, Y. J. Pivotal roles of prolactin and other hormones in lactogenesis and the nutritional composition of human milk. *CEP*. 2020; 63(8):312–313.
8. Vorherr, H. Human lactation and breastfeeding. In Larson, B. L. (ed.), *The Mammary Gland/Human Lactation/Milk Synthesis*. New York, NY: Academic Press, 1978.
9. Cox, D. B., et al. Blood and milk prolactin and the rate of milk synthesis in women. *Exp Physiol*. 1996; 81(6):1007–1020.
10. Neville, M. C. The physiological basis of milk secretion. Part I. Basic physiology. *Ann NY Acad Sci*. 1990; 5:861–868.
11. Vizzari, G., et al. Human milk, more than simple nourishment. *Children*. 2021; 8:863 http://doi.org/10.3390/children8100863.
12. Andreas, N. J., Kampmann, B., & Le-Doore, K. M. Human breastmilk: A review on its composition and bioactivity. *Early Human Dev*. 2015; 91:629–635.
13. Ballard, O., et al. Human milk composition: Nutrients and bioactive factors. *Pediatr Clin North Am*. 2013; 60(1):49–74.
14. Prentice, A. Food and nutrition bulletin. In *Constituents of human milk*. The United Nations University Press, 1996.
15. Gidrewic, D. A., & Fenton, T. R. A systematic review and meta-analysis of the nutrient content of preterm and term breast milk. *BMC Pediatrics*. 2014; 14:216.
16. Koletzko, B., et al. Global standard for the composition of infant formula: Recommendations of an ESPGHAN coordinated international expert group. *J Pediatr Gastroenterol Nutr*. 2005; 41(5):584–599.
17. Lima, M. S., et al. Vitamin E concentration in human milk and associated factors: A literature review. *J Pediatr (Rio J)*. 2014; 90(5):440–448.
18. Williams, H. G. "And not a drop to drink"—Why water is harmful for newborns. *Breastfeed Rev*. 2006; 14(2):5–9.
19. Axelson, I., et al. Protein and energy intake during weaning: I. Effects on growth. *Acta Paediatrica Scandinavica*. 1987; 76(2):321–327.
20. Butte, N. F., et al. Longitudinal changes in milk composition of mothers delivering preterm and term infants. *Early Hum Dev*. 1984; 9(2):153–162.
21. Hediger, M. L., et al. Early infant feeding and growth status of US-born infants and children aged 4–71 mo: Analyses from the third National Health and Nutrition Examination Survey 1988–1994. *Am J Clin Nutr*. 2000; 72(1):159–167.
22. Innis, S. M. Impact of maternal diet on human milk composition and neurological development of infants. *Am J Clin Nutr*. 2014; 99(3):734S–741S.
23. Nishimura, R. Y., et al. Dietary polyunsaturated fatty acid intake during late pregnancy affects fatty acid composition of mature breast milk. *Nutrition*. 2014; 30(6):685–689.
24. Insull, W., et al. The fatty acids of human milk from mothers on diets taken ad libitum. *Biochem J*. 1959; 72:27.
25. Meier, P. P., et al. Mothers' milk feedings in the neonatal intensive care unit: Accuracy of the creamatocrit technique. *J Perinatol*. 2002; 22(8):646–649.
26. Kovacs, A., et al. Fatty acids in early human milk after preterm and full-term delivery. *J Pediatr Gastroenterol Nutr*. 2005; 41(4):454–459.
27. Helland, I. B., et al. Maternal supplementation with very-long-chain n-3 fatty acids during pregnancy and lactation augments children's IQ at 4 years of age. *Pediatrics*. 2003; 111(1):e39–e44.
28. Mosley, E., et al. Trans fatty acids in milk produced by women in the United States. *Am J Clin Nutr*. 2005; 82(6):1292–1297.
29. Ratnayake, W. N., et al. Mandatory trans fat labeling regulations and nationwide product reformulations to reduce trans fatty acid content in foods contributed to lowered concentrations of trans fat in Canadian women's breast milk samples collected in 2009–2011. *Am J Clin Nutr*. 2014; 100(4):1036–1040.
30. Scopesi, F., et al. 7-ketocholesterol in human and adapted milk formulas. *Clin Nutr*. 2002; 21(5):379–384.
31. Kamelska, A. M., et al. Variation of the cholesterol content in breast milk during 10 days collection at early stages of lactation. *Acta Biochim Pol*. 2012; 59(2):243–247.
32. Wong, W. W., et al. Effect of dietary cholesterol on cholesterol synthesis in breast-fed and formula-fed infants. *J Lipid Res*. 1993; 34(8):1403–1141.
33. Lonnerdal, B. et al. Congitudinal evolution of true protein, amino acids and bioactive proteins in breast milk: a developmental perspective. *J Nutr Biochem*. 2017; 41:1–11.
34. Rosen, J. M., et al. Regulatory sequences involved in the hormonal control of casein gene expression. *Ann N Y Acad Sci*. 1986; 464:87–99.
35. Phadke, S. M., et al. Antimicrobial peptides in mucosal secretions: The importance of local secretions in mitigating infection. *J Nutr*. 2005; 135(5):1289–1293.
36. Velona, T., et al. Protein profiles in breast milk from mothers delivering term and preterm babies. *Pediatr Res*. 1999; 45(5 Pt 1):658–663.
37. Wood, E. L., et al. Adjustment of whey: Casein ration from 20:80 to 60:40 in Milk formulation affects food intake and brainstem and hypothalamic neuronal activation and gene expression in laboratory mice. *Foods*. 2021; 10(3):658. doi:10.3390/foods10030658.
38. Newburg, D. S., et al. Carbohydrates in milks: Analysis, quantities, and significance. Jenson, R. G. (Ed.), *Handbook of Milk Composition*. San Diego, CA: Academic Press, 1995:273–349.
39. Morrow, A. L., et al. Human-milk glycans that inhibit pathogen binding protect breast-feeding infants against infectious diarrhea. *J Nutr*. 2005; 135(5):1304–1307.
40. Bode, L. Recent advances on structure, metabolism, and function of human milk oligosaccharides. *J Nutr*. 2006; 136(8):2127–2130.
41. Newburg, D. S., et al. Recent advances in human milk glycobiology. *Pediatr Res*. 2014. 75(5):675–679.
42. Food and Nutrition Board Institute of Medicine. *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic,*

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References

Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. Washington, DC: National Academies Press, 2001.

43. Oliveira-Menegozzo, J. M., et al. Vitamin A supplementation for postpartum women. *Cochrane Database Syst Rev.* 2010; (10):CD005944.
44. Thiele, D. K., et al. Maternal vitamin D supplementation to meet the needs of the breastfed infant: a systematic review. *J Hum Lact*. 2013; 29(2):163–170.
45. Ala-Houhala, M., et al. 25-Hydroxyvitamin D and vitamin D in human milk: Effects of supplementation and season. *Am J Clin Nutr.* 1988; 48(4):1057–1060.
46. Wagner, C. L., & Hollis, B. W. Early Life Effects of Vitamin D: A Focus on Pregnancy and Lactation. *Ann Nutr Metab*. 2020; 76(suppl 2):16–28.
47. Dawodu, A., et al. Mother-child vitamin D deficiency: An international perspective. *Arch Dis Child*. 2007; 92(9):737–740.
48. Haug, M., et al. Vitamin E in human milk from mothers of preterm and term infants. *J Pediatr Gastroenterol Nutr.* 1987; 6(4):605–609.
49. Chappell, J. E., et al. Vitamin A and E content of human milk at early stages of lactation. *Early Hum Dev.* 1985; 11(2):157–167.
50. American Academy of Pediatrics Vitamin K Ad Hoc Task Force. Controversies concerning vitamin K and the newborn. *Pediatrics*. 1993; 91(5):1001–1003.
51. Allen, L. H. B vitamins in breast milk: Relative importance of maternal status and intake, and effects on infant status and function. *Adv Nutr.* 2012; 3(3):362–369.
52. Food and Nutrition Board Institute of Medicine. *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B_6, Folate, Vitamin B_{12}, Pantothenic Acid, Biotin, and Choline*. Washington, DC: National Academies Press, 1998.
53. Dror, D. K., et al. Effect of vitamin B_{12} deficiency on neurodevelopment in infants: Current knowledge and possible mechanisms. *Nutr Rev.* 2008; 66(5):250–255.
54. Butte, N. F., et al. Macro- and trace-mineral intakes of exclusively breast-fed infants. *Am J Clin Nutr.* 1987; 45(1):42–48.
55. Fransson, G. B., et al. Zinc, copper, calcium, and magnesium in human milk. *J Pediatr.* 1982; 101(4):504–508.
56. Atkinson, S. A., et al. Abnormal zinc content in human milk. Risk for development of nutritional zinc deficiency in infants. *Am J Dis Child*. 1989; 143(5):608–611.
57. Duncan, B., et al. Iron and the exclusively breast-fed infant from birth to six months. *J Pediatr Gastroenterol Nutr.* 1985; 4(3):421–425.
58. Pisacane, A., et al. Iron status in breast-fed infants. *J Pediatr.* 1995; 127(3):429–421.
59. Krebs, N. F., et al. Zinc requirements and zinc intakes of breast-fed infants. *Am J Clin Nutr.* 1986; 43(2):288–292.
60. Severi, C., et al. Zinc in plasma and breast milk in adolescents and adults in pregnancy and postpartum: A cohort study in Uruguay. *Nutr Hosp*. 2013; 28(1):223–228.
61. Campus, G., et al. Fluoride content in breast milk after the use of fluoridated food supplement. A randomized trial. *Am J Dent*. 2014; 27(4):199–202.
62. Food and Nutrition Board Institute of Medicine. *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride*. Washington, DC: National Academies Press, 1999:448.
63. McDowell, M. M., et al. Breastfeeding in the United States: Findings from the national health and nutrition examination surveys 1999–2006. *NCHS Data Brief*. 2008; 5:1–8.
64. Palmer, C., et al. Position of the American Dietetic Association: The impact of fluoride on health. *J Am Diet Assoc*. 2005; 105(10):1620–1628.
65. McDaniel, M. R., et al. Sensory characterization of human milk. *J Dairy Sci*. 1989; 72(5):1149–1158.
66. Menella, J. A. Mother's milk: A medium for early flavor experiences. *J Hum Lactation*. 1995; 11:39–45.
67. Hausner, H., et al. Differential transfer of dietary flavour compounds into human breast milk. *Physiol Behav*. 2008; 95(1–2):118–124.
68. Menella, J. A., et al. Experience with a flavor in mother's milk modifies the infants acceptance of flavored cereal. *Developmental Psychobiol*. 1999; 34:197–203.
69. Gerrish, C. J., et al. Flavor variety enhances food acceptance in formula-fed infants. *Am J Clin Nutr.* 2001; 73(6):1080–1085.
70. Schwartz, C., et al. Breast-feeding duration: Influence on taste acceptance over the first year of life. *Br J Nutr.* 2013; 109(6):1154–1161.
71. Lessen, R., et al. Position of the academy of nutrition and dietetics: Promoting and supporting breastfeeding. *J Acad Nutr Diet*. 2015; 115(3):444–449.
72. Kuzela, A. L., et al. Breastfeeding and mother-infant interactions. *J Reprod Infant Psychol*. 1990; 8:185–194.
73. Karlson, E. W., et al. Do breast-feeding and other reproductive factors influence future risk of rheumatoid arthritis? Results from the Nurses' Health Study. *Arthritis Rheum*. 2004; 50(11):3458–3467.
74. Sattari, M., Serwint, J. R., & Levine, D. M. Maternal implications of breastfeeding: A review for the internist. *Am J Med*. 2019; Aug:132(8):912–920.
75. Labbok, M. H., et al. Breastfeeding: maintaining an irreplaceable immunological resource. *Nat Rev Immunol*. 2004; 4(7):565–572.
76. Keeney, S. E., et al. Activated neutrophils and neutrophil activators in human milk: Increased expression of CD11b and decreased expression of L-selectin. *J Leukoc Biol*. 1993; 54(2):97–104.
77. German, J. B., et al. Composition, structure and absorption of milk lipids: A source of energy, fat-soluble nutrients and bioactive molecules. *Crit Rev Food Sci Nutr.* 2006; 46(1):57–92.
78. Sprong, R. C., et al. Bactericidal activities of milk lipids. *Antimicrob Agents Chemother.* 2001; 45(4):1298–1301.
79. Pickering, L. K., et al. Modulation of the immune system by human milk and infant formula containing nucleotides. *Pediatrics*. 1998; 101(2):242–249.
80. World Health Organization. *Global Strategy for Infant and Young Child Feeding*. Geneva, Switzerland, 2003.
81. Hauck, F. R., et al. Breastfeeding and reduced risk of sudden infant death syndrome: A meta-analysis. *Pediatrics*. 2011; 128(1):103–110.
82. American Academy of Pediatrics, Section on Breastfeeding. Breastfeeding and the use of human milk. *Pediatrics*. 2012; 129(3):e827–e841.
83. Ip, S., et al. Breastfeeding and maternal and infant health outcomes in developed countries. *Evid Rep Technol Assess (Full Rep)*. 2007; (153):1–186.
84. Greer, F. R., et al. Effects of early nutritional interventions on the development of atopic disease in infants and children: The role of maternal dietary restriction, breastfeeding, timing of introduction of complementary foods, and hydrolyzed formulas. *Pediatrics*. 2008; 121(1):183–191.
85. Dewey, K. G., et al. Growth of breast-fed and formula-fed infants from 0 to 18 months: the DARLING Study. *Pediatrics*. 1992; 89(6 Pt 1):1035–1041.
86. Evenhouse, E., et al. Improved estimates of the benefits of breastfeeding using sibling comparisons to reduce selection bias. *Health Serv Res*. 2005; 40(6 Pt 1): 1781–1802.
87. Rao, M. R., et al. Effect of breastfeeding on cognitive development of infants born small for gestational age. *Acta Paediatr.* 2002; 91(3):267–274.
88. Smith, M. M., et al. Initiation of breast-feeding among mothers of very low birth weight infants. *Pediatrics*. 2003; 111(6 Pt 1): 1337–1342.
89. Ors, R., et al. Comparison of sucrose and human milk on pain response in newborns. *Eur J Pediatr.* 1999; 158(1):63–66.
90. Shah, P. S., et al. Breastfeeding or breast milk for procedural pain in neonates. *Cochrane Database Syst Rev.* 2006; 3:CD004950.
91. Bartick, M., et al. The burden of suboptimal breastfeeding in the United States: A pediatric cost analysis. *Pediatrics*. 2010; 125(5):e1048–e1056.
92. Ma, P., et al. A case study on the economic impact of optimal breastfeeding. *Matern Child Health J*. 2013; 17(1):9–13.
93. Tuttle, C. R., et al. Establishing the business case for breastfeeding. *Breastfeed Med*. 2009; 4 (Suppl 1):S59–S62.

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References

94. Victoria, C. G., et al. Breastfeeding in the 21st century: Epidemiology, mechanisms, and lifelong effect. *Lancet*. 2016; :387:475–490.
95. Institute of Medicine. *Nutrition During Lactation*. Washington, DC: National Academies Press, 1991:303.
96. Saint, L., et al. Yield and nutrient content of milk in eight women breastfeeding twins and one woman breastfeeding triplets. *Br J Nutr*. 1986; 56:49–58.
97. Dewey, K. G., et al. Infant self-regulation of breast milk intake. *Acta Paediatr Scand*. 1986; 75(6):893–898.
98. Daly, S. E. J., et al. Infant demand and milk supply. Part 2: The short-term control of milk synthesis in lactating women. *J Hum Lactation*. 1995; 11:27–37.
99. Daly, S. E., et al. Infant demand and milk supply. Part 1: Infant demand and milk production in lactating women. *J Hum Lact*. 1995; 11(1):21–26.
100. Daly, S. E., et al. The short-term synthesis and infant-regulated removal of milk in lactating women. *Exp Physiol*. 1993; 78(2):209–220.
101. Hill, P. D., et al. Breastfeeding experience and milk weight in lactating mothers pumping for preterm infants. *Birth*. 1999; 26(4):233–238.
102. Niefert, M., et al. Practical aspects of breastfeeding the premature infant. *Perinatol Neonatol*. 1988; 12:24.
103. Souto, G. C., et al. The impact of breast reduction surgery on breastfeeding performance. *J Hum Lact*. 2003; 19(1):43–49; quiz 66–69, 120.
104. Hurst, N. Breastfeeding after breast augmentation. *J Hum Lact*. 2003; 19(1):70–71.
105. Brown, S. L., et al. Breast implant surveillance reports to the U.S. Food and Drug Administration: Maternal-child health problems. *J Long Term Eff Med Implants*. 2006; 16(4):281–290.
106. Semple, J. L., et al. Breast milk contamination and silicone implants: Preliminary results using silicon as a proxy measurement for silicone. *Plast Reconstr Surg*. 1998; 102(2):528–533.
107. Morland-Schultz, K., et al. Prevention of and therapies for nipple pain: A systematic review. *J Obstet Gynecol Neonatal Nurs*. 2005; 34(4):428–437.
108. Wooldrige, M. S., et al. Colic, "overfeeding" and symptoms of lactose malabsorption in the breast-fed baby. *Lancet*. 1988; 2:382–384.
109. Butte, N. F., et al. Feeding patterns of exclusively breast-fed infants during the first four months of life. *Early Hum Dev*. 1985; 12(3):291–300.
110. Brams, M., et al. "Nursing bottle caries" in breast-fed children. *J Pediatr*. 1983; 103:415–416.
111. Palmer, B. The influence of breastfeeding on the development of the oral cavity: A commentary. *J Hum Lact*. 1998; 14(2):93–98.
112. American Academy of Pediatrics. Controversies concerning vitamin K and the newborn. American Academy of Pediatrics Committee on Fetus and Newborn. *Pediatrics*. 2003; 112(1 Pt 1):191–192.
113. Ross, A.C., et al. The 2011 Dietary Reference Intakes for Calcium and Vitamin D: What dietetics practitioners need to know. *J Am Diet Assoc*. 2011; 111(4):524–527.
114. Wagner, C. L., et al. Prevention of rickets and vitamin D deficiency in infants, children, and adolescents. *Pediatrics*. 2008; 122(5):1142–1152.
115. Institute of Medicine Food and Nutrition Board. *Dietary Reference Intakes for Calcium and Vitamin D*. Washington, DC: National Academies Press, 2011.
116. United States Department of Agriculture and United States Department of Health and Human Services. *Dietary Guidelines for Americans, 2020–2025*. 9th Edition. December 2020. Available at DietaryGuidelines.gov.
117. Institute of Medicine Food and Nutrition Board. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients)*. Washington, DC: National Academies Press, 2002.
118. National Academies of Sciences, Engineering, and Medicine. 2023. *Dietary Reference Intakes for Energy*. Washington, DC: The National Academies Press. doi: https://doi.org/10.17226/26818.
119. Institute of Medicine. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids*. Washington, DC: National Academies Press, 2005:xxv, 1331.
120. Goldberg, G. R., et al. Longitudinal assessment of energy expenditure in pregnancy by the doubly labeled water method. *Am J Clin Nutr*. 1993; 57:494–505.
121. Roberts, S., et al. Lactational performance in relation to energy intake in the baboon. *Am J Clin Nutr*. 1985; 41:1270–1276.
122. Endres, L. K., et al. Postpartum weight retention risk factors and relationship to obesity at 1 year. *Obstet Gynecol*. 2015; 125(1):144–152.
123. Neville, C. E., et al. The effectiveness of weight management interventions in breastfeeding women—a systematic review and critical evaluation. *Birth*. 2014. 41(3):223–236.
124. Strode, M. A., et al. Effects of short-term caloric restriction on lactational performance of well-nourished women. *Acta Paediatr Scand*. 1986; 75(2):222–229.
125. Dusdieker, L. B., et al. Is milk production impaired by dieting during lactation? *Am J Clin Nutr*. 1994; 59(4):833–840.
126. Lovelady, C. A., et al. The effects of dieting on food and nutrient intake of lactating women. *J Am Diet Assoc*. 2006; 106(6):908–912.
127. Mohammad, M. A., et al. Effect of dietary macronutrient composition under moderate hypocaloric intake on maternal adaptation during lactation. *Am J Clin Nutr*. 2009; 89(6):1821–1827.
128. Lovelady, C. A., et al. Lactation performance of exercising women. *Am J Clin Nutr*. 1990; 52(1):103–109.
129. Institute of Medicine. *Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate*. Washington, DC: National Academies Press, 2005.
130. Lust, K. D., et al. Maternal intake of cruciferous vegetables and other foods and colic symptoms in exclusively breast-fed infants. *J Am Diet Assoc*. 1996; 96(1):46–48.
131. Hill, D. J., et al. A low allergen diet is a significant intervention in infantile colic: Results of a community-based study. *J Allergy Clin Immunol*. 1995; 96(6 Pt 1):886–892.
132. Partty, A., et al. Gut microbiota and infant distress—the association between compositional development of the gut microbiota and fussing and crying in early infancy. *Microb Ecol Health Dis*. 2012; 23.
133. Schreck Bird A., et al. Probiotics for the treatment of infantile colic. *J Pharm Practice*. 2017:30(3):366–374.
134. Sung, V., et al. Probiotics to prevent or treat excessive infant crying: Systematic review and meta-analysis. *JAMA Pediatr*. 2013; 167(12):1150–1157.
135. Institute of Medicine, Committee on Leading Health Indicators for Healthy People 2020. *Leading Health Indicators for Healthy People 2020: Letter Report*. Washington, DC: National Academies Press, 2011:xiii, 84.
136. Healthy People 2030, retrieved from https://health.gov/healthypeople/about, March 2022.
137. Ponk, N.P., Kleinman, D. V., & Richmond, T. S. Healthy People 2030: Moving toward equitable health and well-being in the United States. *E Clinical Medicine*. 2021; 6:33:100777.
138. U.S. Department of Health and Human Services. *HHS Blueprint for Action on Breastfeeding*. Washington, DC: U.S. Department of Health and Human Services, Office on Women's Health, 2000.
139. Bentley, M. E., et al. Sources of influence on intention to breastfeed among African-American women at entry to WIC. *J Hum Lact*. 1999; 15(1):27–34.
140. Asiodu, I. V., et al. Breastfeeding and use of social media among first-time African American mothers. *J Obstet Gynecol Neonatal Nurs*. 2015; 44(2):268–278.
141. Bryant, C., et al. *Best Start's Three Step Counseling Strategy*. Tampa, FL: Best Start 1997.
142. Pisacane, A., et al. A controlled trial of the father's role in breastfeeding promotion. *Pediatrics*. 2005; 116(4):e494–e498.
143. McCamman, S., et al. Breastfeeding success: You can make the difference. *Perinatal Nutr Report*. 1998; 4(Winter):2–4.

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References

144. Dyson, L., et al. Interventions for promoting the initiation of breastfeeding. *Cochrane Database Syst Rev*. 2005; (2):CD001688.
145. Shealy, K. R., et al. *The CDC Guide to Breastfeeding Intervention*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2005.
146. Petrova, A., et al. Effectiveness of exclusive breastfeeding promotion in low-income mothers: A randomized controlled study. *Breastfeed Med*. 2009; 4:63–69.
147. Barron, S. P., et al. Factors influencing duration of breast feeding among low-income women. *J Am Diet Assoc*. 1988; 88(12):1557–1561.
148. Guendelman, S., et al. Juggling work and breastfeeding: Effects of maternity leave and occupational characteristics. *Pediatrics*. 2009; 123(1):e38–e46.
149. Mirkovic, K. R., et al. Maternity leave duration and full-time/part-time work status are associated with US mothers' ability to meet breastfeeding intentions. *J Hum Lact*. 2014; 30(4):416–419.
150. Meehan, K., et al. The association between an electric pump loan program and the timing of requests for formula by working mothers in WIC. *J Hum Lact*. 2008; 24(2):150–158.
151. World Health Organization. *International Code of Marketing of Breast-milk Substitutes*. WHO: Geneva, Switzerland, 1981.
152. Stremler, J., et al. Insight from a breastfeeding peer support pilot program for husbands and fathers of Texas WIC participants. *J Hum Lact*. 2004; 20(4):417–422.
153. Merten, S., et al. Do baby-friendly hospitals influence breastfeeding duration on a national level? *Pediatrics*. 2005; 116(5):e702–e708.
154. Baxter, R. J. Kaiser Permanente's commitment to breastfeeding. *Breastfeed Med*. 2014; 9(7):345–346.
155. Khoury, A. Social Marketing Institute success stories: National WIC breastfeeding promotion project. Available at http://www.socialmarketing.org/success/cs-nationalwic.html. [2001, Mississippi WIC Program.]
156. World Health Organization. *Protecting, Promoting, and Supporting Breastfeeding. The Special Role of Maternity Services (a joint WHO/UNICEF statement)*. WHO/UNICEF: Geneva, Switzerland, 1989.
157. Avery, A., et al. Confident commitment is a key factor to sustained breastfeeding. *Birth*. 2009; 36(2):141–148.
158. Renfrew, M. J., et al. Support for healthy breastfeeding mothers with healthy term babies. Cochrane Database Syst Rev. 2012; 5:CD001141.
159. Bryant, C., et al. A strategy for promoting breastfeeding among economically disadvantaged women and adolescents. *Clin Issu Perinat Women's Health Nurs*. 1992; 3(4):723–730.
160. Kim, J. H., Shin, J. C., & Donovan, S. M. Effectiveness of workplace lactation interventions on breastfeeding outcomes in the United States: An updated systematic review. *J Hum Lact*. 2019; 35(1):100–113.
161. Splett, P. L., et al. *The Economic Benefits of Breastfeeding an Infant in the WIC Program: Twelve Month Follow-up Study*. Washington, DC: Food and Consumer Service, U.S. Department of Agriculture, 1998.
162. Wave, J. L., et al. African American breastfeeding peer support: All moms empowered to nurse. *Breastfeed Med*. 2021; 16(2):156–164.

Chapter 7

1. Lessen, R., & Kavanagh, K. Position of the Academy of Nutrition and Dietetics: Promoting and supporting breastfeeding. *J Acad Nutr Diet*. 2015; 115(3): 444–449.
2. Mitchell, K. B., & Johnson, H. M. Challenges in the management of breast conditions during lactation. *Obstet Gynecol Clin North Am*. 2022; 49(1): 35–55. doi: 10.1016/j.ogc.2021.11.002.
3. Buck, M. L., Amir, L. H., Cullinane, M., & Donath. S. M. Nipple pain, damage, and vasospasm in the first 8 weeks postpartum. *Breastfeed Med*. 2014; 9(2):56–62.
4. Mass, S. Breast pain: Engorgement, nipple pain and mastitis. *Clin Obstet Gynecol*. 2004; 47:676–682.
5. Walker, M. Conquering common breast-feeding problems. *J Perinat Neonat Nurs*. 2008; 22:267–274.
6. Puapornpong, P., Paritakul, P., Suksamarnwong, M., Srisuwan, S., & Ketsuwan, S. Nipple pain incidence, the predisposing factors, the recovery period, after care management, and the exclusive breastfeeding outcome. *Breastfeed Med*. 2017; 12:169–173.
7. Inch, S. Breastfeeding problems: Prevention and management. *Community Pract*. 2006; 79:165–167.
8. Breastfeeding Challenges: ACOG Committee Opinion Number 280. *Obstet Gynecol*. 2021 Feb 1; 137(2):e42-e53. doi:10.1097/AOG.0000000000004253.
9. Wambach, K., & Spencer, B. *Breastfeeding and Human Lactation*, 6th ed. Burlington, MA: Jones & Bartlett Learning, 2021.
10. Smith, J. W., & Tully, M. R. Midwifery management of breastfeeding: Using the evidence. *J Midwifery Women's Health*. 2001; 46:423–438.
11. Martin, C., & Krebs, N. F. *The Nursing Mother's Problem Solver*. New York, NY: Simon & Schuster, 2000.
12. Lawrence, R. A., & Lawrence, M. L. *Breastfeeding: A Guide for the Medical Professional*, 9th ed. Minneapolis, MN: Mosby, 2021.
13. Vazirinejad, R., Darakhshan, S., Esmaeili, A., & Hadadian, S. The effect of maternal breast variations on neonatal weight gain in the first seven days of life. *Int Breastfed J*. 2009; 4:13. doi:1186/1746-4358-4-13.
14. Kvist, L. J. Re-examination of old truths: Replication of a study to measure the incidence of lactational mastitis in breastfeeding women. *Int Breastfeeding J*. 2013; 8:2.
15. Academy of Breastfeeding Medicine: Clinical Protocol #32: Management of Hyperlactation. *Breastfed Med*. 2020; 15(3). doi:10.1089/bfm.2019.29141.htm.
16. Mangesi, L., & Dowswell, T. Treatments for breast engorgement during lactation. *Cochrane Database Syst Rev*. 2016; 6:CD006946. doi:10.1002/14651858.
17. Academy of Breastfeeding Medicine. Clinical Protocol 20: Engorgement, Revised 2016. *Breastfeed Med*. 2016; 11(4):159–163.
18. Walker, M. *Breastfeeding Management for the Clinician: Using the Evidence*, 2nd ed. Burlington, MA: Jones & Bartlett, 2011:550–551.
19. Academy of Breastfeeding Medicine. Clinical Protocol #36: The Mastitis Spectrum, Revised 2022. *Breastfeed Med*. 2022; 17(5). doi: 10.1089/bfm.2022.2907.kbm
20. Lau, C. The effects of stress on lactation. *Pediatr Clin North Am*. 2001; (48)1:221–234.
21. Matheson, I., et al. Bacteriological findings and clinical symptoms in relation to clinical outcome in puerperal mastitis. *Acta Obstet Gynecol Scand*. 1988; 67:723–726.
22. Academy of Breastfeeding Medicine: Clinical Protocol #9: Use of galactogogues in initiating or augmenting maternal milk secretion. *Breastfeed Med*. 2011; 6(1):41–49.
23. Hale, T. W., & Hartmann, P. E. *Hale & Hartmann's Textbook of Human Lactation*, 1st ed. Plano, TX: Hale Publishing, 2007:479.
24. USLCA Press Release: Orphan Drug Designation for Domperidone in the U.S. Available at www.breastfeeding.org accessed January 2018
25. Lawrence, R. A., & Lawrence, R. M. *Breastfeeding: A Guide for the Medical Profession*, 8th ed. St Louis, MO: Mosby, Inc., 2016.
26. Temming, L. A., Cahill, A. G., & Riley, L. E. Clinical management of medications in pregnancy and lactation. *Am J Obstet Gynecol*. 2016; 214(6):698–702.
27. Hale, T. W. *Medications and Mother's Milk 2017*, 19th ed. New York, NY: Springer, 2020.
28. Lagoy, C. T., et al. Medication use during pregnancy and lactation: An urgent call for public health action. *J Women's Health*. 2005; 14:104–109.
29. Food and Drug Administration. Pregnancy and Lactation Labeling (Drugs) Final Rule. Available at https://www.fda.gov/Drugs/DevelopmentApprovalProcess/DevelopmentResources/Labeling/ucm093307.htm, accessed January 1, 2018.

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References

30. Berlin, C. M., & Briggs, G. G. Drugs and chemicals in human milk. *Semin Fetal Neonatal Med*. 2005; 10:149–159.
31. Begg, E. J., et al. Studying drugs in human milk: Time to unify the approach. *J Hum Lact*. 2002; 18:323–332.
32. Sachs, H. C., AAP Committee on Drugs. Clinical report: The transfer of drugs and therapeutics into human milk: An update on selected topics. *Pediatrics*. 2013; 132:e796–e809.
33. Amir, L. H., Rirotta, M. V., & Raval, M. Breastfeeding—Evidence-based guidelines for the use of medicines. *Aust Fam Physician*. 2011; 40(9):684–690.
34. Department of Child and Adolescent Health. Breastfeeding and Maternal Medication: Recommendations for Drugs in the Eleventh WHO Model List of Essential Drugs, 2003. UNICEF, World Health Organization, 2003.
35. Committee on Nutrition, American Academy of Pediatrics. *Pediatric Nutrition Handbook*, 1st ed. Elk Grove Village, IL: American Academy of Pediatrics, 2004.
36. Chung, A. M., Reed, M. D., & Blumer, J. L. Antibiotics and breast-feeding: A critical review of the literature. *Paediatr Drugs*. 2002; 4:817–837.
37. Diaz, S. Contraceptive implants and lactation. *Contraception*. 2002; 65:39–46.
38. Guthmann, R. A., Bang, J., & Nashelsky, J. Combined oral contraceptives for mothers who are breastfeeding. *Am Fam Physician*. 2005; 72:1303–1304.
39. Nice, F. J., Snyder, J. L., & Kotansky, B. C. Breastfeeding and over-the-counter medications. *J Hum Lact*. 2000; 16:319–331.
40. The complete German Commission E monographs: *Therapeutic Guide to Herbal Medicines*. Boston, MA: Integrative Medicine Communications, 1998.
41. Hardy, M. L. Herbs of special interest to women. *J Am Pharm Assoc*. (Wash.) 2000; 40:234–242.
42. Scott, C. R., & Jacobson, H. A. Selection of international nutritional & herbal remedies for breastfeeding concerns. *Midwifery Today*. 2005; 38–39.
43. Mortel, M., & Mehta, S. D. Systematic review of the efficacy of herbal galactogogues. *J Hum Lact*. 2013; 29(2):154–162.
44. Humphrey, S. L., & McKenna, D. J. Herbs and breastfeeding. *Breastfeed Abstracts*. 1997; 17:11–12.
45. Conover, E., & Buehler, B. A. Use of herbal agents by breastfeeding women may affect infants. *Pediatr Ann*. 2004; 33:235–240.
46. Woolf, A. D. Herbal remedies and children: Do they work? Are they harmful? *Pediatrics*. 2003; 112:240–246.
47. Humphrey, S. Sage advice on herbs and breastfeeding. *LEAVEN*. 1998; 34:43–47.
48. Leung, A., & Foster, S. *Encyclopedia of Common Natural Ingredients Used in Foods, Drugs, and Cosmetics*. New York, NY: John Wiley & Sons, 1996.
49. Cunningham, E., & Hansen, K. Question of the month: Where can I get information on evaluating herbal supplements? *J Am Diet Assoc*. 1999; 99:1240.
50. The American Botanical Council. *The ABC Clinical Guide to Herbs*. Austin, TX: American Botanical Council, 2005.
51. Cartwright, M. M. Herbal use during pregnancy and lactation: A need for caution. American Dietetic Association Public Health/Community Nutrition Practice Group. *The Digest (Summer)*. 2001; 1–3.
52. Klier, C. M., et al. St. John's wort (*Hypericum perforatum*) and breastfeeding: Plasma and breast milk concentrations of hyperforin for 5 mothers and 2 infants. *J Clin Psychiatry*. 2006; 67(2):305–309.
53. Lee, A., et al. The safety of St. John's wort (*Hypericum perforatum*) during breastfeeding. *J Clin Psychiatry*. 2003; 64(8):966–968.
54. Gabay, M. P. Galactogogues: Medications that induce lactation. *J Hum Lact*. 2002; 18:274–279.
55. Betzold, C. M. Galactagogues. *J Midwifery Women's Health*. 2004; 49:151–154.
56. American Academy of Pediatrics Policy Statement: Breastfeeding and the use of Human Milk. *Pediatrics*. 2012; 129:e827–e841.
57. Haastrup, M. B., Potteg, A., & Damkier, P. Alcohol and breastfeeding. *Basic Clin Pharmacol Toxicol*. 2014; 114:168–173.
58. Giglia, R., & Binns, C. Alcohol and lactation: A systematic review. *Nutrition and Dietetics* 2006; 63:103.
59. Ho, E., et al. Alcohol and breast-feeding: Calculation of time to zero level in milk. *Biol Neonate*. 2001; 80:219–222.
60. Mennella, J. A., Pepino, M. Y., & Teff, K. L. Acute alcohol consumption disrupts the hormonal milieu of lactating women. *J Clin Endocrinol Metab*. 2005; 90:1979–1985.
61. Mennella, J. A. Regulation of milk intake after exposure to alcohol in mothers' milk. *Alcohol Clin Exp Res*. 2001; 25:590–593.
62. Mennella, J. A., & Gerrish, C. J. Effects of exposure to alcohol in mother's milk on infant sleep. *Pediatrics*. 1998; 101:E2.
63. Mennella, J. A., & Garcia Comez, P. L. Sleep disturbances after acute exposure to alcohol in mother's milk. *Alcohol Int Biomed J*. 2001; 25:153–158.
64. Gunzerath, L., et al. National Institute on Alcohol Abuse and Alcoholism report on moderate drinking. *Alcohol Clin Exp Res*. 2004; 28:829–847.
65. Little, R. E., et al. Maternal alcohol use during breast-feeding and infant mental and motor development at one year. *N Engl J Med*. 1989; 321:425–430.
66. Mohrbacher, N., & Stock, J. *The Breastfeeding Answer Book*. Schaumburg, IL: La Leche League International, 2003.
67. Subcommittee on Nutrition During Lactation, Committee on Nutritional Status During Pregnancy and Lactation. *Food and Nutrition Board Institute of Medicine National Academy of Sciences. Nutrition During Lactation: Summary, Conclusions, and Recommendations*. Washington, DC: National Academy Press, 1991.
68. Napierala, M., Mazela J., Merritt, T. A., & Florek, E. Tobacco smoking and breastfeeding: Effect on the lactation process, breastmilk composition and infant development. A critical review. *Environ Res*. 2016; 151:321–338.
69. Dempsey, D. A., & Benowitz, N. L. Risks and benefits of nicotine to aid smoking cessation in pregnancy. *Drug Saf*. 2001; 24:277–322.
70. Amir, L. H., & Donath, S. M. Does maternal smoking have a negative physiological effect on breastfeeding? The epidemiological evidence. *Birth*. 2002; 29:112–123.
71. Ilett, K. F., et al. Use of nicotine patches in breast-feeding mothers: Transfer of nicotine and cotinine into human milk. *Clin Pharmacol Ther*. 2003; 74:516–524.
72. Chapman, D. J. Short-term effects of smoking on breastfed infants. *J Hum Lact*. 2008; 24(1):92–93.
73. Dahlstrom, A., et al. Nicotine and cotinine concentrations in the nursing mother and her infant. *Acta Paediatr Scand*. 1990; 79:142–147.
74. Gaffney, K. F. Postpartum smoking relapse and becoming a mother. *J Nurs Scholarsh*. 2006; 38:26–30.
75. Nickerson, K. Environmental contaminants in breast milk. *J Midwifery Women's Health*. 2006; 51:26–34.
76. Baeza-Loya, S., et al. Perceptions about e-cigarette safety may lead to e-smoking during pregnancy. *Bull Menninger Clin*. 2014 Summer; 78(3):243–252.
77. The Women's—The Royal women's hospital fact sheet: Vaping and e-cigarettes during pregnancy and breastfeeding. August 2021. Available at thewomens.r.worldssl.net/images/upload/fact-sheets/vapingE-cigarettes.pdf, accessed March 2022.
78. McBride, M., & Haile, Z.T. Association between electronic nicotine delivery systems use and breastfeeding duration. *Breastfed Med*. 2021; 16(11):886–893. doi: 10.1089/bf.2021.0132.Epub July 22, 2021.
79. Baker, T., Datta, P., Rewers-Felkins, K., Thompson, H., Kallem, R. R., & Hale, T. W. Transfer of inhaled cannabis into human breast milk. *Obstet Gynecol*. 2018 May; 131(5):783–788. doi: 10.1097/AOG.0000000000002575.
80. Fernandez-Ruiz, J., et al. Cannabinoids and gene expression during brain development. *Neurotox Res*. 2004; 6:389–401.
81. Hill, M., & Reed, K. Pregnancy, breastfeeding, and marijuana: A review article. *Obstet Gynecol Surv*. October 2013; 68(10):710–718. doi: 10.1097/01.ogx.0000435371.51584.d1.
82. Academy of Breastfeeding Medicine Clinical Protocol #21: Guidelines for breastfeeding and substance use or substance use disorder, revised 2015. *Breastfeed Med*. 2015; 10(3):135–141.
83. Notice of Correction: Ryan, S. A., Ammerman, S. D., & O'Connor, M. E. AAP Committee on Substance Use and Prevention; AAP Section on Breastfeeding. Marijuana use during pregnancy and breastfeeding: Implications for neonatal and childhood outcomes.

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References

Pediatrics. 2018;142(3):e20181889. *Pediatrics*. 2018 Aug 27:e20181889A. doi: 10.1542/peds.2018-1889A. Epub ahead of print. Erratum for: *Pediatrics*. 2018 Aug 27. PMID: 30150211.

84. Norman, R. J., & Nisenblat, V. The effects of caffeine on reproductive outcomes in women. *UpToDate*. Updated February 6, 2014, accessed December 1, 2017.
85. Rivera-Calimlim, L. The significance of drugs in breast milk. Pharmacokinetic considerations. *Clin Perinatol*. 1987; 14:51–70.
86. FDA Drug Safety Communication: FDA restricts use of prescription codeine pain and cough medicines and tramadol pain medicines in children; recommends against use in breastfeeding women. Available at www.fda.gov/Drugs/DrugSafety /lucm549679.htm, accessed January 2018.
87. MacMillan, K. D. L. Neonatal abstinence syndrome: Review of epidemiology, care models, and current understanding of outcomes. *Clin Perinatol*. 2019 Dec; 46(4):817–832. doi: 10.1016/j. clp.2019.08.012. Epub August 14, 2019.
88. Chu, L., McGrath, J. M., Qiao, J., Brownell, E., Recto, P., Cleveland, L. M., Lopez, E., Gelfond, J., Crawford, A., & McGlothen-Bell, K. A Meta-analysis of breastfeeding effects for infants with neonatal abstinence syndrome. *Nurs Res*. 2022 Jan–Feb 01; 71(1):54–65. doi: 10.1097/ NNR.0000000000000555.
89. World Health Organization. Safe food: Crucial for child development. Available at www.who.int/ceh/publications/en /poster15new.pdf, accessed October 2006.
90. Massart, F., et al. Human breast milk and xenoestrogen exposure: A possible impact on human health. *J Perinatol*. 2005; 25:282–288.
91. Wang, R. Y., et al. Human milk research for answering questions about human health. *J Toxicol Environ Health*. 2005; 68:1771–1801.
92. Agency for Toxic Substances and Disease Registry—ATSDR. Per- and polyfluoroalkl substances (PFAs) and Breastfeeding. November 2021. Available at asdr.cdc.gov /pfas/health-effects/pfas-breastfeeding.html.
93. Condon, M. Breast is best, but it could be better: What is in breast milk that should not be? *Pediatr Nurs*. 2005; 31:333–338.
94. Haddad, S., Ayotte, P., & Verner, M. A. D. Derivation of exposure factors for infant lactational exposure to persistent organic pollutants (POPs). *Regul Toxicol Pharmacol*. 2015; 71:135–140.
95. Schreiber, J. S. Parents worried about breast milk contamination. What is best for baby? *Pediatr Clin North Amer*. October 2001; 48(5):11113–11127, viii.
96. Centers for Disease and Control and Prevention. Breastfeeding: Exposure to Environmental Toxins. Updated April 2010. Available at http://www.cdc.gov/breastfeeding/disease/environmental_toxins.htm.
97. World Health Organization. Report of the WHO working group on the assessment of health risks for human infants from exposure to PCDDs, PCDFs, PCBs. *Chemosphere*. 1998; 57:1627–1643.
98. Pronczuk, J., et al. Global perspectives in breast milk contamination: Infectious and toxic hazards. *Environ Health Perspect*. 2002; 110:A349–A351.
99. American Academy of Pediatrics Subcommittee on Hyperbilirubinemia. Management of hyperbilirubinemia in the newborn infant 35 or more weeks of gestation. *Pediatrics*. 2004; 114:297–316.
100. Academy of Breastfeeding Medicine. Clinical Protocol #22: Guidelines for management of jaundice in the breastfeeding infant equal to or greater than 35 weeks' gestation, revised 2017. *Breastfeeding Med*. 2017; 12(5):250–257.
101. Cohen, S. M. Jaundice in the full-term newborn *Pediatr Nurs*. 2006; 32:202–208.
102. Stokowski, L. A. Early recognition of neonatal jaundice and kernicterus. *Adv Neonatal Care*. 2002; 2:101–114.
103. Watchko, J. F. Vigintiphobia revisited. *Pediatrics*. 2005; 115:1747–1753.
104. Bhutani, V. K., & Johnson, L. Kernicterus in the 21st Century: Frequently asked questions. *J Perinatol*. 2009; 29:S20–S24.
105. Seagraves, K., Brulte, A., McNeely, K., & Pritham, U. Supporting breastfeeding to reduce newborn readmissions for hyperbilirubinemia. *Nurs Womens Health*. 2013; 17(6):498–508.
106. Joint Commission on Accreditation of Healthcare Organizations. Kernicterus threatens healthy newborns. *Sentinel Event Alert*. April 2001; 18.
107. Stark, A. R., & Lannon, C. M. System changes to prevent severe hyperbilirubinemia and promote breastfeeding: Pilot approaches. *J Perinatol*. 2009; 29:S.53–S.57.
108. Gartner, L. M., & Herschel, M. Jaundice and breastfeeding. *Pediatr Clin North Am*. 2001; 48:389–399.
109. Reiser, D. J. Neonatal jaundice: Physiologic variation or pathologic process. *Crit Care Nurs Clin North Am*. 2004; 16:257–269.
110. Moerschel, S. K., Clanciaruso, L. B., & Tracy, L. R. A practical approach to neonatal jaundice. *Amer Fam Phys*. 2008; 77(9):1255–1262.
111. Reiser, D. J. Hyperbilirubinemia. AWHONN. *Lifelines*. 2001; 5:55–61.
112. AAP Subcommittee on Neonatal Pediatrics. Neonatal jaundice and kernicterus. *Pediatrics*. 2001; 108:763–765.
113. Gartner, L. M. Breastfeeding and jaundice. *J Perinatol*. 2001; 21(Suppl 1):S25–S29.
114. Gourley, G. R. Breast-feeding, neonatal jaundice and kernicterus. *Semin Neonatol*. 2002; 7:135–141.
115. Nilsson, I. M. S., Strandberg-Larsen, K., Knight, C. H., Hansen, A. V., & Kronborg, H. Focused breastfeeding counselling improves short- and long-term success in an early-discharge setting: A cluster-randomized study. *Matern Child Nutr*. 2017 Oct; 13(4):e12432. doi: 10.1111/ mcn.12432. Epub February 14, 2017.
116. Willis, S. K., Hannon, P. R., & Scrimshaw, S. C. The impact of the maternal experience with a jaundiced newborn on the breastfeeding relationship. *J Fam Pract*. 2002; 51:465.
117. Geraghty, S. R., et al. Breast milk feeding rates of mothers of multiples compared to mothers of singletons. *Ambul Pediatr*. 2004; 4:226–231.
118. Births: Final Data for 2020.National Vital Statistics Reports: 2022 Feb; 70(12). Available at cdc.gov/nchs/data/nsvr/nvsr70/ nsvr70-17.pdf, accessed March 2022.
119. Flidel-Rimon, O., & Shinwell, E. S. Breastfeeding multiples. *Semin Neonatol*. 2002; 7:231–239.
120. Gromada, K. K., & Spangler, A. K. Breastfeeding twins and higher-order multiples. *J Obstet Gynecol Neonatal Nurs*. 1998; 27:441–449.
121. Gromada, K. K. Breastfeeding more than one: Multiples and tandem breastfeeding. NAACOGS. *Clin Issu Perinat Women's Health Nurs*. 1992; 3:656–666.
122. Auer, C., & Gromada, K. K. A case report of breastfeeding quadruplets: Factors perceived as affecting breastfeeding. *J Hum Lact*. 1998; 14:135–141.
123. Palmer, G. *The Politics of Breastfeeding*, 2nd ed. London: Pandora Press/Harper Collins, 1993:32.
124. Saint, L., Maggiore, P., & Hartmann, P. E. Yield and nutrient content of milk in eight women breast-feeding twins and one woman breast-feeding triplets. *Br J Nutr*. 1986; 56:49–58.
125. Snyder, K., & Worlton, G. Social Support During COVID-19: Perspectives of Breastfeeding Mothers. *Breastfeed Med*. 2021 Jan; 16(1):39–45. doi: 10.1089/ bfm.2020.0200. Epub December 23, 2020.
126. Hattori, R., & Hattori, H. Breastfeeding twins: Guidelines for success. *Birth*. 1999; 26:37–42.
127. Geraghty, S. R., Khoury, J. C., & Kalkwarf, H. J. Comparison of feeding among multiple-birth infants. *Twin Res*. 2004; 7:542–547.
128. Porta, R., Capdevila, E., Botet, F., Ginovart, G., Moliner, E., Nicolàs, M., Gutiérrez, A., Ponce-Taylor, J., & Verd, S. Breastfeeding Disparities between Multiples and Singletons by NICU Discharge. *Nutrients*. 2019 Sep 12; 11(9):2191. doi: 10.3390/nu11092191.
129. Zeiger, R. S., & Friedman, N. J. The relationship of breastfeeding to the development of atopic disorders. *Nestle Nutr Workshop Ser Pediatr Program*. 2006; 57:93–105.
130. O'Connell, E. J. Pediatric allergy: A brief review of risk factors associated with developing allergic disease in childhood. *Ann Allergy Asthma Immunol*. 2003; 90:53–58.
131. Greer, F. R., Sicherer, S. H., Burks, A. W.; Committee on Nutrition; Section on Allergy and Immunology The Effects of Early Nutritional Interventions on the Development of Atopic Disease in Infants and Children: The Role of Maternal Dietary Restriction, Breastfeeding, Hydrolyzed Formulas, and Timing of Introduction of Allergenic

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References

Complementary Foods. *Pediatrics*. 2019 Apr; 143(4):e20190281. doi: 10.1542/peds.2019-0281. Epub March 18, 2019.

132. Burks, A. W., et al. NIAID-Sponsored 2010 guidelines for managing food allergy: Applications in the pediatric population. *Pediatrics*. 2011; 128(5):955–965.
133. Guidelines for the diagnosis and management of food allergy in the United States: Report of the NIAID sponsored expert panel. *J Allergy & Clin Immunol*. 2010; 126(6):S1–S58.
134. Abrams, E. M., & Becker, A. B. Food Introduction and allergy prevention in infants. *CMAJ*. 2015; 187(17):1297–1301.
135. Johnson, J. D., Cocker, K., & Chang, E. Infantile Colic; Recognition and Treatment. *Am Fam Physician*. 2015 Oct 1; 92(7):577–582.
136. Hill, D. J., et al. Effect of a low-allergen maternal diet on colic among breastfed infants: A randomized, controlled trial. *Pediatrics*. 2005; 116:e709–e715.
137. Mennella, J. A., & Beauchamp, G. K. The effects of repeated exposure to garlic-flavored milk on the nursling's behavior. *Pediatr Res*. 1993; 34:805–808.
138. Mennella, J. A., & Beauchamp, G. K. Maternal diet alters the sensory qualities of human milk and the nursling's behavior. *Pediatrics*. 1991; 88:737–744.
139. Cooper, R. L., & Cooper, M. M. Red pepper-induced dermatitis in breast-fed infants. *Dermatology*. 1996; 193:61–62.
140. Zeretzke, K. Allergies and the breastfeeding family. *New Beginnings*. 1998; 15(4):100.
141. Davidoff, M. J., et al. Changes in the gestational age distribution among U.S. singleton births: Impact on rages of late preterm birth, 1992–2002. *Semin Perinatol*. 2006; 30(1):8–15.
142. Meier, P., Patel, A. L., Wright, K., & Engstrom, J. L. Management of breastfeeding during and after the maternity hospitalization for late preterm infants. *Clin Perinatol*. December 2013; 40(4):689–705.
143. Engle, W. A., Tomashed, K. M., Wallman, C.; Committee on Fetus and Newborn. "Late-Preterm" Infants: A population at risk. AAP clinical report. *Pediatrics*. 2007; 120(6):1390–1401.
144. Academy of Breastfeeding Medicine. Clinical Protocol #10: Breastfeeding the late preterm and early term infants, second revision 2016. *Breastfeed Med*. 2016; 11(10):494–500.
145. Shulman, R. J., et al. Early feeding, feeding tolerance, and lactase activity in preterm infants. *J Pediatr*. 1998; 133:645–649.
146. Spatz, D. L. State of the science: Use of human milk and breast-feeding for vulnerable infants. *J Perinat Neonatal Nurs*. 2006; 20:51–55.
147. Callen, J., & Pinelli, J. A review of the literature examining the benefits and challenges, incidence and duration, and barriers to breastfeeding in preterm infants. *Adv Neonatal Care*. 2005; 5:72–88.
148. Rodriguez, N. A., Miracle, D. J., & Meier, P. P. Sharing the science on human milk feedings with mothers of very-low-birth-weight infants. *JOCNN*. 2005; 34:109–119.
149. Schanler, R. J., Shulman, R. J., & Lau, C. Feeding strategies for premature infants: Beneficial outcomes of feeding fortified human milk versus preterm formula. *Pediatrics*. 1999; 103:1150–1157.
150. Spatz, D. L. Ten steps for promoting and protecting breastfeeding for vulnerable infants. *J Perinat Neonatal Nurs*. 2004; 18:385–396.
151. Sisk, P. M., et al. Lactation counselling for mothers of very low birth weight infants: Effect on maternal anxiety and infant intake of human milk. *Pediatrics*. 2006; 117:67–75.
152. Hilditch, C., Howes, A., Dempster, N., & Keir, A. What evidence-based strategies have been shown to improve breastfeeding rates in preterm infants? *J Paediatr Child Health*. 2019 Aug; 55(8):907–914. doi: 10.1111/jpc.14551. Epub June 22, 2019.
153. Lawrence, R. M., & Lawrence, R. A. Breast milk and infection. *Clin Perinatol*. 2004; 31:501–528.
154. Lawrence, R. M., & Lawrence, R. A. Given the benefits of breastfeeding, what contraindications exist? *Pediatr Clin North Am*. 2001; 48:235–251.
155. Newell, M. L. Current issues in the prevention of mother-to-child transmission of HIV-1 infection. *Trans R Soc Trop Med Hyg*. 2006; 100:1–5.
156. Elimination of Mother-to-Child Transmission. July 2021. Available at data.unicef.org/topic/hivaids/emtct, accessed March 2022.
157. Dorosko, S. M. Vitamin A, mastitis, and mother-to-child transmission of HIV-1 through breast-feeding: Current information and gaps in knowledge. *Nutr Rev*. 2005; 63:332–346.
158. UNAIDS Children and HIV Fact Sheet. Available at http://www.aidsdatahub.org/sites/default/files/publication/UNAIDS_FactSheet_Children_2016.pdf, accessed January 2018.
159. American Academy of Pediatrics, Section on Breastfeeding. Breastfeeding and the use of human milk. *Pediatrics*. 2012; 129:e827–e841.
160. World Health Organization. Guideline Updates on HIV and Infant Feeding. Geneva, Switzerland: World Health Organization, 2016.
161. Coutsoudis, A. Breastfeeding and the HIV-positive mother: The debate continues. *Early Hum Dev*. 2005; 81:87–93.
162. Academy of Breastfeeding Medicine. Clinical Protocol #8: Human milk storage information for home use for full-term infants, revised 2017. *Breastfeed Med*. 2017; 12(7):390–395.
163. Academy of Nutrition and Dietetics: Pediatric Nutrition Dietetics Practice Group. *Infant and Pediatric Feedings: Guidelines for Preparation of Human Milk and Formula in Health Care Facilities*. 3rd ed. Chicago IL, 2019.
164. Jones, F. *Best Practice for Expressing, Storing and Handling Human Milk in Hospitals, Homes, and Child Care Settings*, 3rd ed. Fort Worth, TX: Human Milk Banking Association of North America, 2011.
165. Mohrbacher, N., & Kendall-Tackett, K. *Breastfeeding Made Simple: Seven Natural Laws for Nursing Mothers*. Oakland, CA: New Harbinger Publications, 2005.
166. Lang, S. *Breastfeeding Special Care Babies*. China: Elsevier Health, 2002.
167. Jones, F. History of North American donor milk banking: One hundred years of progress. *J Hum Lact*. 2003; 19:313–318.
168. HMBANA.org, accessed January 2018.
169. Keim, S. A., et al. Microbial contamination of human milk purchased via the Internet. *Pediatrics*. November 1, 2013; 132:e1227–e1235.
170. Paxson, C. I. Survival of human milk leukocytes. *J Pediatr*. 1979; 94:61–64.
171. Prolacta. Available at http://www.prolacta.com/.
172. Hear Her Campaign. Center for Disease Control available at cdc.gov/hearher/about-the-campaign/indes.html, accessed March 2022.
173. Meier, P. P., et al. The Rush Mother's Milk Club: Breastfeeding interventions for mothers with very low birth weight infants. *JOGNN*. 2004; 33:164–174.

Chapter 8

1. Ziegler, E. E. The term infant. In Duggan, C., Watkins, J.B., & Walker, W. A. (Eds.), *Nutrition in Pediatrics*, 4th ed. Hamilton, ON: BC Decker Inc., 2008:403–410.
2. Zlotkin, S. Neonatal nutrition. In Linder, M. A. (Ed.), *Nutritional Biochemistry and Metabolism with Clinical Applications*. New York: Elsevier Science Publishing Co., Inc., 1991:349–371.
3. Prado, E. L., & Dewey, K. G. Nutrition and brain development in early life. *Nutr Rev*. 2014; 72(4):267–284.
4. American Academy of Pediatrics, American College of Obstetrics and Gynecology. *Guidelines for Perinatal Care*, 8th ed. Washington, DC: American College of Obstetrics and Gynecology, 2017.
5. Chumlea, W. C., & LaMonte, M. Physical growth and maturation. In Samour, P. Q., & King, K. (Eds.), *Pediatric Nutrition*. Sudbury, MA: Jones & Bartlett Learning, 2012:23–34.
6. Schwarzenberg S. J., & Georgieff, M. K. AAP Committee on Nutrition. Advocacy for improving nutrition in the first 1000 days to support childhood development and adult health. *Pediatrics*. 2018; 141(2):E20173716.
7. Healthy People 2030 Objectives. Available at https://health/gov/healthypeople, accessed December 9, 2021.
8. Martin, J. A., et al. *National Vital Statistics Report. Births: Final Data for 2019*. 2021; 70(2).
9. Ely, D. M., & Driscoll, A. K. Infant Mortality in the United States, 2019: Data

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References

from the Period Linked Birth/Infant Death File. 2021; 70(14). U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics.

10. Organisation of Economic Co-Operation and Development (OECD), Infant Mortality Rates (indicator). doi: 10.1787/83dea506-en. Accessed December 9, 2021.
11. MacDorman, M. F., & Matthews, T. J. Understanding Racial and Ethnic Disparities in U.S. Infant Mortality Rates. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics. NCHS Data Brief, Number 74, September 2011.
12. Lorenz, J. M., et al. Infant mortality in the United States. *J Perinatol*. 2016; (36):797–801.
13. Blumenshine, P., et al. Socioeconomic disparities in adverse outcomes: A systematic review. *Am J Prev Med*. 2010; 39(3)263–272.
14. Centers for Medicare & Medicaid Services. Children's Health Insurance Program. Available at Medicaid.gov, accessed September 25, 2018.
15. U.S. Centers for Medicare & Medicaid Services. Early and Periodic Screening, Diagnostic and Treatment. Available at Medicaid.gov, accessed December 9, 2021.
16. Hagan, J. F., et al. *Bright Futures: Guidelines for Health Supervision of Infants, Children and Adolescents*, 3rd ed. Elk Grove Village, IL: American Academy of Pediatrics, 2008.
17. Holt, K., et al. *Bright Futures Nutrition*, 3rd ed. Elk Grove Village, IL: American Academy of Pediatrics, 2011.
18. Fanaroff, A. A., et al. Very low birth weight outcomes of the National Institute of Child Health and Human Development Neonatal Research Network. *Am J Obstet Gyn*. 1995; 167:1499–1505.
19. Barker, D. Human growth and disease in later life. In Duggan, C., Watkins, J. B., & Walker, W. A. (Eds.), *Nutrition in Pediatrics*, 4th ed. Hamilton, ON: B.C. Decker Inc., 2008:305–309.
20. Kail, R. V., & Cavanaugh, J. C. *Human Development: A Lifespan View*, 8th ed. Boston, MA: Cengage Learning, Inc. 2019.
21. Caring for Your Baby and Young Child: Birth to Age 5. American Academy of Pediatrics. 2009. Available at healthychildren.org, accessed December 9, 2021.
22. Gardner, J. M., et al. Zinc supplementation and psychosocial stimulation: Effects on the development of undernourished Jamaican children. *Am J Clin Nutr*. 2005; 82:399–405.
23. Hobbie, C., et al. Parental understanding of basic infant nutrition: Misinformed feeding choices. *J Pediatr Health Care*. 2000; 14:26–31.
24. American Academy of Pediatrics. Development of Gastrointestinal Function. In Kleinman, R. E., & Greer, F. R. (Eds), *Pediatric Nutrition*, 7th ed. Elk Grove Village, IL: American Academy of Pediatrics, 2014:15–40.
25. Thomas, D. W., & Greer, F. R. Clinical report: Probiotics and prebiotics in pediatrics. *Pediatr*. 2010; 126:1217–1231.
26. Gonzales Ayerbe, J. I., et al. Diagnosis and management of gastroesophageal reflux disease in infants and children: From guidelines to clinical practice. *Practical Gastroenterology, Hepatology and Nutrition*. 2019; 22(2):107–121.
27. Faith, M. S., & Hittner, J. B. Infant temperament and eating style predict change in standardized weight status and obesity risk at 6 years of age. *Int J Obes*. 2010; 34:1515–1523.
28. National Academy of Sciences, Engineering, and Medicine. 2020. Feeding Infants and Children from Birth to 24 Months: Summarizing Existing Guidance. (Washington, DC: The National Academies Press).
29. Dietary Guidelines for Americans 2020–2025. U.S. Department of Agriculture. DietaryGuidelines.gov, accessed December 9, 2021.
30. Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein and Amino Acids*. (Washington, DC: National Academies Press, 2005).
31. American Academy of Pediatrics. Protein. In Kleinman, R. E., & Greer, F. R. (Eds.), *Pediatric Nutrition*, 8th ed. Itasca, IL: American Academy of Pediatrics, 2020:449–479.
32. Milner, J. A., & Allison, R. G. The role of dietary fat in child nutrition and development: Summary of an ASNS workshop. *J Nutr*. 1999; 129: 2094–2105.
33. Krohn, K., et al. Macronutrient requirements for growth: Fats and fatty acids. In Duggan, C., Watkins, J. B., & Walker, W. A. (Eds.), *Nutrition in Pediatrics*, 4th ed. Hamilton, ON: B.C. Decker Inc., 2008:59–65.
34. Lawrence, R. A., & Lawrence, R. M. *Breastfeeding: A Guide for the Medical Profession*, 7th ed. Maryland Heights, MO: Elsevier Mosby, 2011.
35. American Academy of Pediatrics. Fats and Fatty Acids. In Kleinman, R. E., Greer, F. R. (Eds.), *Pediatric Nutrition*, 8th ed. Itasca, IL: American Academy of Pediatrics, 2020:509–539.
36. American Academy of Pediatrics. Diet, Nutrition and Oral Health. In Kleinman, R. E., Greer, F. R. (Eds.), *Pediatric Nutrition*, 8th ed. Itasca, IL: American Academy of Pediatrics, 2020:1327–1344.
37. Esala, S., et al. Effect of fluorine intake on breast milk fluorine content. *Br J Nutr*. 1982; 48:201–204.
38. Clark, M. B., Keels, M. A., & Slayton, R. L., AAP Section on Oral Health. Fluoride use in caries prevention in the primary care setting. *Pediatrics*. 2020; 146(6):e2020034637.
39. Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride*. Washington, DC: National Academies Press, 1997.
40. Kupka, R., et al. Vitamins. In Duggan, C., Watkins, J. B., & Walker, W.A. (Eds), *Nutrition in Pediatrics*. Hamilton, ON: B.C. Decker Inc., 2009:99-114.
41. Hollis, B. W., et al. Vitamin D and its metabolites in human and bovine milk. *J Nutr*. 1981; 111:1240–1248.
42. Wagner, C. L., & Greer, F. R. Prevention of rickets and vitamin D deficiency in infants, children, and adolescents. *Pediatrics*. 2010; 126:1040–1050.
43. Institute of Medicine Food and Nutrition Board. *Dietary Reference Intakes: Water, Potassium, Sodium, Chloride and Sulfate*. Washington, DC; National Academies Press, 2004.
44. Khambalia, A. Z., & Zlotkin, S. Iron. In Duggan, C., Watkins, J. B., & Walker, W. A. (Eds.), *Nutrition in Pediatrics*, 4th ed. Hamilton, ON: B.C. Decker Inc., 2008:83-98.
45. Lozoff, B., et al. Long-lasting neural and behavioral effects of iron deficiency in infancy. *Nutr Rev*. 2006; 64:S34–S91.
46. Rao, R., & Georgieff, M. K. Perinatal aspects of iron metabolism. *Acta Paediatr Suppl*. 2002; 91:124–129.
47. Smith, N. J., & Rios, E. Iron metabolism and iron deficiency in infancy and childhood. *Adv Pediatr*. 1974; 21:239–280.
48. Baker, R., & Greer, F. R. Clinical Report: Diagnosis and prevention of iron deficiency and iron-deficiency anemia in infants and young children (0–3 years of age). *Pediatrics*. 2010; 126:1040–1050.
49. American Academy of Pediatrics. Complementary Feeding. In Kleinman, R. E., & Greer, F. R. (Eds.), *Pediatric Nutrition*, 8th ed. Itasca, IL: American Academy of Pediatrics, 2020:163–186.
50. Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium and Zinc*. Washington, DC National Academy Press, 2001.
51. WHO Multicentre Growth Reference Study Group. WHO Child Growth Standards. Geneva, Switzerland: World Health Organization, 2006.
52. Turck, D., et al. World Health Organization 2006 child growth standards and 2007 reference charts: A discussion paper by the Committee on Nutrition of the European Society for Pediatric Gastroenterology, Hepatology, and Nutrition. *J Pediatr Gastroenterol Nutr*. 2013; 57(2):258–264.
53. Grummer-Strawn, L. M., Reinold, C., & Krebs, N. F. Use of World Health Organization and CDC growth charts for children aged 0-59 months in the United States. *MMWR Recom Rep*. 2010; 59(RR-9):1–15.
54. American Academy of Pediatrics. Policy Statement: Breastfeeding and the use of human milk. *Pediatrics*. 2012; 129:e827–e841.

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References

55. Academy of Nutrition and Dietetics. Practice paper of the Academy of Nutrition and Dietetics: Promoting and supporting breastfeeding. *J Acad Nutr Diet*. 2015.
56. Brown, K. H. Complementary feeding. In Duggan, C., Watkins, J. B., & Walker, W. A. (Eds.), *Nutrition in Pediatrics*, 4th ed. Hamilton, ON: B.C. Decker Inc., 2008:411–416.
57. Perez-Escamilla, R., et al.; on behalf of the RWJF HER Expert Panel on Best Practices for Promoting Healthy Nutrition, Feeding Patterns, and Weight Status for Infants and Toddlers from Birth to 24 months. *Feeding Guidelines for Infants and Young Toddlers: A Responsive Parenting Approach*. Durham, NC: Healthy Eating Research, 2017. Available at http://healthyeatingresearch.org, accessed March 13, 2022.
58. Department of Health and Human Services. Current good manufacturing practices, quality control procedures, quality factors notification requirement, and records and reports for infant formula. *Fed Regist*. 2014; 79(111):33057–33072.
59. Texas Children's Hospital, *Pediatric Nutrition Reference Guide*, 12th ed. Houston, TX: Texas Children's Hospital, 2019.
60. Lott, M., et al. Healthy Beverage Consumption in Early Childhood: Recommendations from Key National Health and Nutrition Organizations. Consensus Statement. Durham, NC: Healthy Eating Research, 2019. Available at http://healthyeatingresearch.org, accessed March 13, 2022.
61. Rapley, G., & Muurkett, T. *Baby-Led Weaning The Essential Guide*. New York, The Experiment, 2019.
62. World Health Organization. "Infant and young child feeding." *Factsheets*, 9 June 2021. Available at https://www.who.int/news-room/fact-sheets/detail/infant-and-young-child-feeding.
63. Bentley, A. *Inventing Baby Food: Taste, Health, and the Industrialization of the American Diet*. Oakland, CA, University of California Press, 2014.
64. Morison, B. J., Heath, A. M., Haszard, J. J., Hein, K., Fleming, E. A., Daniels, L., Erickson, E. W., Fangupo, L. J., Wheeler, B. J., Taylor, B. J., & Taylor, R. W. Impact of a modified version of baby-led weaning on dietary variety and food preferences in infants. *Nutrients*. 2018; 10(8):1092. doi: https://doi.org/10.3390/nu10081092.
65. Rowan, H., Lee, M., & Brown, A. Differences in dietary composition between infants introduced to complementary foods using baby-led weaning and traditional spoon feeding. *J Hum Nutr Diet*. 2019; 32(1):11–20. doi: https://doi.org/10.1111/jhn.12616.
66. Taylor, R. W., Williams, S. M., Fangupo, L. J., Wheeler, B. J., Taylor, B. J., Daniels, L., Fleming, E. A., McArthur, J., Morison, B., Erickson, L. W., Davies, R. S., Bacchus, S., Cameron, S. L., & Heath, A. M. Effect of a baby-led approach to complementary feeding on infant growth and overweight: A randomized clinical trial. *JAMA Pediatr*. 2017; 171(9):838–846. doi: https://doi.org/10.1001/jamapediatrics.2017.1284.
67. Brown, A. No difference in self-reported frequency of choking between infants introduced to solid foods using a baby-led weaning or traditional spoon-feeding approach. *J Hum Nutr Diet*. 2018; 31(4):496–504. doi: https://doi.org/10.1111/jhn.12528.
68. Cameron, S. L., Taylor, R. W., & Heath, A. L. Development and pilot testing of baby-led introduction to solids—A version of baby-led weaning modified to address concerns about iron deficiency, growth faltering and choking. *BMC Pediatr*. 2015; 15:99. doi: https://doi.org/10.1186/s12887-015-0422-8.
69. Fangupo, L. J., Heath, A. M., Williams, S. M., Erickson Williams, L. W., Morison, B. J., Fleming, E. A., Taylor, B. J., Wheeler, B. J., & Taylor, R. W. A baby-led approach to eating solids and risk of choking. *Pediatrics*. 2016; 138(4):e20160772. doi: https://doi.org/10.1542/peds.2016-0772.
70. Daniels, L., Taylor, R. W., Williams, S. M., Gibson, R. S., Samman, S., Wheeler, B. J., Taylor, B. J., Fleming, E. A., Hartley, N. K., & Heath, A. M. Modified version of baby-led weaning does not result in lower zinc intake or status in infants: A randomized controlled trial. *J Acad Nutr Diet*. 2018; 118(6):1006–1016.e1. doi: https://doi-org.libproxy.sdsu.edu/10.1016/j.jand.2018.02.005.
71. World Health Organization. "Infant and young child feeding." Factsheets, 9 June 2021. Available at https://www.who.int/news-room/fact-sheets/detail/infant-and-young-child-feeding.
72. Tervo, R. Parent's reports predict their child's developmental problems. *Clin Pediatr*. 2005; 44:601–611.
73. American Academy of Pediatric Dentistry. Perinatal and infant oral health care. The Reference Manual of Pediatric Dentistry. Chicago, IL: American Academy of Pediatric Dentistry, 2021:262–266. Accessed at aapd.org on March 13, 2022.
74. American Academy of Pediatrics. Formula Feeding of Term Infants. In Kleinman, R. E., Greer, F.R. (Eds), *Pediatric Nutrition*, 8th ed. Itasca, IL: American Academy of Pediatrics. 2020:79–112.
75. Ziegler, E. E., Fomon, S. J., Nelson, S. E., et al. Cow milk feeding in infancy: Further observations on blood loss from the gastrointestinal tract. *J Pediatr*. 1990; 116(1):11–18.
76. Liu, T., Howard, R. M., Mancini, A .J., et al. Kwashiorkor in the United States: Fad diets, perceived and true milk allergy, and nutritional ignorance. *Arch Dermatol*. 2001; 137(5):630–636.
77. Heyman, M. B., & Abrams, S. A. Section on Gastroenterology, Hepatology, and Nutrition, A.A.P. Committee on Nutrition. Fruit juice in infants, children and adolescents: Current recommendations. *Pediatrics*. 2017; 139(6):e20170967.
78. Bleich, S. N., & Vercammen, K. A. The negative impact of sugar-sweetened beverages on children's health: An update of the literature. *BMC Obes*. 2018; 5(6).
79. Chapin, M. M., et al. Nonfatal choking on food among children 14 years or younger in the United States, 2001–2009. *Pediatrics*. 2013; 132(2):275–281.
80. American Academy of Pediatrics. Policy statement on prevention of choking among children. *Pediatrrics*. 2010; 125:601–607.
81. Ventura, A. K., & Worobey, J. Early influences on the development of food preferences. *Curr Biol*. 2013; 23(9):R401–R408.
82. Menella, J. A., & Beachamp, G. Maternal diet alters the sensory qualities of human milk and the nursling' behavior. *Pediatrics*. 1991; 88:737–744.
83. Birch, L. L., & Fisher, J.O. Development of eating behaviors among children and adolescents. *Pediatrics*. 1998; 101:539–549.
84. Zero to Three. Available at https://www.zerotothree.org/, accessed March 10, 2022.
85. USDA, Food and Nutrition Service. Infant Nutrition and Feeding—A Guide for Use in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC), 2019. Available at https//wicworks.fns.usda.gov, accessed on January 15, 2022.
86. U.S. Department of Health and Human Services National Heart, Lung and Blood Institute. Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents: Summary Report, 2012. Available at U.S. Department of Health and Human Services, National Heart, Lung and Blood Institute. Accessed at hhs.gov on March 13, 2022.
87. American Academy of Pediatrics. Policy Statement: Media use by children younger than 2 years. *Pediatrics*. 2011; 128:1040–1045.
88. Krebs, N. F., et al. Meat as a first complementary food for breastfed infants: Feasibility and impact on zinc intake and status. *J Pediatr Gastroenterol Nutr*. 2006; 42(2):207–214.
89. Mangels, A. R., & Messina, V. Considerations in planning vegan diets: Infants. *J Am Diet Assoc*. 2001; 101:670–677.
90. Academy of Nutrition and Dietetics. Position of the Academy of Nutrition and Dietetics: Vegetarian diets. *J Acad Nutr Diet*. 2016; 116:1970–1980.
91. Donaldson, M. Metabolic vitamin B_{12} status on a mostly raw vegan diet with follow-up using tablets, nutritional yeast, or probiotic supplements. *Ann Nutr Metab*. 2000; 44:229–234.
92. Cohen-Silver, J., & Ratnapalan, S. Management of infantile colic: A review. *Clin Pediatr*. 2009; 48(1):14–17.
93. Hill, D. J., & Hosking, C. S. Infantile colic and food hypersensitivity. *J Pediatr Gastroenterol Nutr*. 2000; 30(1):S67–S76.
94. Metcalf, T. J., et al. Simethicone in the treatment of infant colic. *Pediatrics*. 1994; 94:29–34.
95. Ong, T. G., et al. Probiotics to prevent infantile colic (Review). *Cochrane Database of Systematic Reviews* 2019, Issue 3. Art. No.:CD012473.

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References

96. Hill, D. J., et al. Effect of a low-allergen maternal diet on colic among breastfed infants: A randomized controlled trial. *Pediatrics*. 2005; 116:e709–e715.
97. Centers for Disease Control and Prevention. The management of acute diarrhea in children: oral rehydration, maintenance, and nutritional therapy. *MMWR*. 1992; 41(RR-16);001.
98. Burpee, T., & Duggan, C. Diarrheal diseases. In Duggan, C., Watkins, J. B., & Walker, W. A. (Eds.), *Nutrition in Pediatrics*, 4th ed. Hamilton, ON: B.C. Decker Inc., 2008:631–640.
99. American Academy of Pediatrics. Oral therapy for acute diarrhea. In Kleinman, R. E., & Greer, F. R. (Eds.), *Pediatric Nutrition*. Elk Grove Village, IL: American Academy of Pediatrics, 2014:717–726.
100. Isaacs, J. S. Fluid and bowel problems. In Lucas, B. (Ed.), *Children with Special Health Care Needs: Nutrition Care Handbook*). Chicago, IL: American Dietetic Association, 2004:103–118.
101. American Academy of Pediatrics. Policy Statement: The use and misuse of fruit juice in pediatrics. *Pediatrics*. 2001; 107(5):1210–1213.
102. DiSanto, C., & Duggan, C. Gastrointestinal diseases. In Hendricks, K. M., & Duggan, C. (Eds.), *Manual of Pediatric Nutrition*, 4th ed. Hamilton, ON: B.C. Decker, 2005:531-568.
103. Loening-Baucke, V. Constipation in early childhood: Patient characteristics, treatment, and long term follow up. *Gut*. 1993; 34:1400–1404.
104. Tabbers, M. M., et al. Evaluation and treatment of functional constipation in infants and children: Evidence-based recommendations from ESPGHAN and NASPGHAN. *J Pediatr Gastroenterol Nutr*. 2014; 58:258–274.
105. U.S. Department of Health and Human Services, National Institutes of Health, National Institute of Allergy and Infectious Diseases. *Guidelines for the Diagnosis and Management of Food Allergy in the United States*. Washington, DC: U.S. Government Printing Office, 2010.
106. Greer, F. R., et al. Clinical Report: Effects of early nutritional interventions on the development of atopic disease in infants and children: The role of maternal dietary restriction, breastfeeding, timing of introduction of complementary foods, and hydrolyzed formulas. *Pediatrics*. 2008; 121:183–191.
107. Sicherer, S. H., & Wood, R.A. Allergy testing in childhood: Using allergen-specific IgE tests. *Pediatrrics*. 2012; 129:193–197.
108. American Academy of Pediatrics. Food Allergy. In Kleinman, R. E., Greer, F. R. (Eds.), *Pediatric Nutrition*, 7th ed. Elk Grove Village, IL: American Academy of Pediatrics, 2014:845–862.
109. Heyman, M. B. AAP Committee on Nutrition. Lactose intolerance in infants, children and adolescents. *Pediatrics*. 2006; 118(3):1279–1286.
110. American Academy of Pediatrics. Carbohydrate and dietary fiber. In Kleinman, R. E., Greer, F. R. (Eds.), *Pediatric Nutrition*, 8th ed. Itasca, IL: American Academy of Pediatrics, 2020:481–508.
111. Schulman, R. J., Feste, A., & Ou, C. Absorption of lactose, glucose polymers, or combination in premature infants. *J Pediatr*. 1995: 127:626–631.
112. Bock, S. A., et al. Fatalities due to anaphylactic reactions to foods. *J Allergy Clin Immunol*. 2001; 107:191–193.
113. Bock, S. A., et al. Further fatalities caused by anaphylactic reactions to food, 2001–2006. *J Allergy Clin Immunol*. 2007; 119:1016–1018.
114. Togias, A., et al. Addendum guidelines for the prevention of peanut allergy in the United States: Report of the National Institute of Allergy and Infectious Diseases -sponsored expert panel. *World Allergy Organization J*. 2017; 10:1–18.
115. DuToit, G., et al.; for the LEAP Study Team. Randomized trial of peanut consumption in infants at risk for peanut allergy. *N Eng J Med*. 2015; 372:803–813.
116. Greer, F. R., Sicherer, S. H., & Burks, A. W. AAP Committee on Nutrition, AAP Section on Allergy and Immunology. The effects of early interventions on the development of atopic disease in infants and children: The role of maternal dietary restriction, breastfeeding, hydrolyzed formulas, and timing of introduction of allergenic complementary foods. *Pediatrics*. 2019; 143(4):e20190281.
117. VanWinckel, M., et al. Clinical Practice: Vegetarian infant and child nutrition. *Eur J Pediatr*. 2011; 170(12):1489–1494.
118. Fewtrell, M., et al. Complementary feeding: A position paper by the European Society for Paediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) Committee on Nutrition. *JPGN*. 2017; 64:119–132.
119. Amit, M. Canadian Paediatric Society, Community Paediatrics Committee. Position Statement: Vegetarian diets in children and adolescents. *Paediatr Child Health*. 2010; 15(5):303–308.
120. American Academy of Pediatrics. Nutritional Aspects of Vegetarian Diets. In Kleinman, R. E., & Greer, F. R. (Eds.), *Pediatric Nutrition*, 8th ed. Itasca, IL: American Academy of Pediatrics, 2020:293–319.
121. Sanders, T. A. B., & Reddy, S. The influence of a vegetarian diet on the fatty acid composition of human milk and the essential fatty acid status of the infant. *J Pediatr*. 1992; 120(Suppl):S71–S77.
122. Paul, I. M., et al. Opportunities for the primary prevention of obesity during infancy. *Adv Pediatr*. 2009; 56(1):107–133.
123. Early Head Start, Available at eclkc.ohs.acf.hhs.gov, accessed on March 10, 2022.
124. Centers for Disease Control and Prevention. Morbidity and Mortality Weekly Report, CDC Grand Rounds: Newborn Screening and Improved Outcomes, June 1, 2012. Available at cdc.gov, accessed January 22, 2022.

Chapter 9

1. American Academy of Pediatrics Committee on Nutrition. Nutritional Support of Children with Developmental Disabilities. In Kleinman R. E., & Greer, F. R., (Eds.), *Pediatric Nutrition*, 8th ed. Itasca, IL: American Academy of Pediatrics, 2020:1043–1063.
2. Health Resources and Services Administration, Maternal and Child Health. Children and Youth with Special Health Care Needs (CYSHCN). Available at mchb.hrsa.gov, accessed January 22, 2022.
3. Lichtenwalter, L., et al. Providing nutrition services to children with special needs in a community setting. *Topics in Clin Nutr*. 1993; 8(4):75–78.
4. Bayerl, C. T., & Ries, J. Nutrition issues of children in early intervention programs: Primary care team approach. *Semin Pediatr Gastroenterol Nutr*. 1993; 4:11–15.
5. Koletzko, B., & Uauy, R. Defining the Nutritional Needs of Preterm Infants. In B. Koletzko, B. Poindexter, & R. Uauy (Eds.), *Nutritional care of preterm infants*. Basel, Switzerland: Karger. 2014; 110:4-10.
6. Murphy, S. L,. et al. Mortality in the United States, 2020. National Center for Health Statistics Data Brief. No 427, December 2021. cdc.gov, accessed January 22, 2022.
7. Saigal, S., et al. Physical growth and current health status of infants who were of extremely low birth weight and controls at adolescence. *Pediatrics*. 2001; 108:407–415.
8. Ehrenkranz, R. A., et al. Growth in the neonatal intensive care unit influences neurodevelopmental and growth outcomes of extremely low birth weight infants. *Pediatrics*. 2006; 117:1253–1261.
9. Raju, T. N., et al. Optimizing care and outcome for late-preterm (near term) infants: A summary of the workshop sponsored by the National Institute of Child Health and Human Development. *Pediatrics*. 2006; 118(3):1207–1214.
10. Engle, W. A., et al. "Late-Preterm" infants: A population at risk. *Pediatrics*. 2007; 120(6):1390–1401.
11. Bright Futures. Children and Adolescents with Special Health Care Needs. In Holt, K., Wooldridge, N., Story, M., & Sofka, D. (Eds.), *Bright Futures: Nutrition*. Elk Grove Village, IL: American Academy of Pediatrics, 2011:123–129.
12. O'Bryan, A. M. Prematurity. In Hendricks, K. M., & Duggan, C. (Eds.), *Manual of Pediatric Nutrition*, 4th ed. Hamilton, ON: B.C. Decker, 2005:690–709.
13. American Academy of Pediatrics. Nutritional Needs of the Preterm Infant. In Kleinman, R. E., & Greer, F. R. (Eds.), *Pediatric Nutrition Handbook*, 8th ed. Itasca, IL: American Academy of Pediatrics, 2020:113–162.
14. Zemel, B., & Stallings, V. Developmental Disabilities. In: Duggan, C., Watkins, J. B., & Walker, W.A. (Eds.), *Nutrition in Pediatrics*, 4th ed. Hamilton, ON: B.C. Decker, Inc., 2008:497–504.

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References

15. Institute of Medicine, Food and Nutrition Board. *Dietary References for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein and Amino Acids (Macronutrients)*. Washington, DC: National Academies Press, 2002.
16. National Academies of Sciences, Engineering, and Medicine. *Dietary Reference Intakes for Energy*. Washington, DC: The National Academies Press, 2023. doi: https://doi.org/10.17226/26818.
17. Cloud, H. H. Developmental Disabilities. In: Samour, P. Q., King, K. (Eds.), *Pediatric Nutrition*, 4th ed. Sudbury, MA: Jones & Bartlett Learning, 2012:219–238
18. Agostoni, C., et al. Enteral nutrient supply for preterm infants: Commentary from the European Society of Paediatric Gastroenterology, Hepatology and Nutrition. *J Pediatr Gastroenterol Nutr.* 2010; 50(1):85–91.
19. Tudehope, D., et al. Nutritional needs of the micropreterm infant. *J Pediatr.* 2013; 162:S72–S80.
20. Ramel, S. E., & Georgieff, M. K. Preterm Nutrition and the Brain. In Koletzko, B., Poindexter, B., & Uauy, R. (Eds.), *Nutritional Care of Preterm Infants*. Basel, Switzerland: Karger, 2014:190–200.
21. Ramel, S. E., et al. The relationship of poor linear growth velocity with neonatal illness and two-year neurodevelopment in preterm infants. *Neonatology*. 2012; 102:19–24.
22. Pongcharoen, T., et al. Influence of prenatal and postnatal growth on intellectual functioning in school aged children. *Arch Pediatr Adolesc Med*. 2012; 166:411–416.
23. Mehta, N. M., & Jaksic, T. The Critically Ill Child. In Duggan, C., Watkins, J. B., & Walker, W. A. (Eds.), *Nutrition in Pediatrics,* 4th ed. Hamilton, ON: B.C. Decker Inc., 2008:663–673
24. Dewey, K. G., et al. Protein requirements of infants and children. *Eur J Clin Nutr.* 1996; 50(Suppl 1):S119–S147.
25. American Academy of Pediatrics. Formula Feeding of Term Infants. In Kleinman, R. E., & Greer, F. R. (Eds.), *Pediatric Nutrition*, 7th ed. Elk Grove Village, IL: American Academy of Pediatrics, 2014:61–81.
26. Acosta, P. B. Genetic Screening and Nutritional Management. In Samour, P. Q., & King, K. (Eds.), *Pediatric Nutrition*, 4th ed. Sudbury, MA: Jones & Bartlett Learning, 2012:179–217.
27. Krohn, K., et al. Macronutrient Requirements for Growth: Fats and fatty acids. In Duggan, C., Watkins, J. B., & Walker, W. A. (Eds.), *Nutrition in Pediatrics*, 4th ed. Hamilton, ON: B.C. Decker Inc., 2008:59–65
28. Picciano, M. F. Nutrient composition of human milk. *Pediatr Clin North Am*. 2001; 48:53–67.
29. Lapillonne, A. Enteral and parenteral lipid requirements for preterm infants. In Koletko, B., Poindexter, B., & Uauy, R. (Eds.), *Nutritional Care of Preterm Infants*). Basel, Switzerland: Karger, 2014:110:82–98.
30. Gura, K. M., & Chan, L. Drug Therapy and the Role of Nutrition. In Duggan, C., Watkins, J. B., & Walker, W. A. (Eds.), *Nutrition in Pediatrics*, 4th ed. Hamilton, Ontario, Canada: B.C. Decker Inc., 2008:191–208.
31. American Academy of Pediatrics. Inborn Errors of Metabolism. In Kleinman, R. E., & Greer, F. R. (Eds.), *Pediatric Nutrition*, 8th ed. Itasca, IL: American Academy of Pediatrics, 2020;829–849.
32. Baker, R. D., & Greer, F. Clinical Report—Diagnosis and prevention of iron deficiency and iron-deficiency anemia in infants and young children (0–3 years of age). *Pediatrics*. 2010; 126(5):1040–1050.
33. Redding, E., & Despino, S. Pulmonary diseases. In: Samour, P. Q., & King, K. (Eds.), *Pediatric Nutrition*. Sudbury, MA: Jones & Bartlett Learning, 2012:239–274.
34. Ziegler, E. E. Human Milk and Human Milk Fortifiers. In Koletzko, B., Poindexter, B, & Uauy, R. (Eds.), *Nutritional Care of Preterm Infants*. Basel, Switzerland: Karger, 2014;215–227.
35. Fenton, T. R., & Kim, J. A systematic review and meta–analysis to revise the Fenton growth chart for preterm infants. *BMC Pediatr.* 2013; 13:59.
36. Olsen, I. E., et al. New intrauterine growth curves based on United States data. *Pediatrics*. 2010; 125:e214–e224.
37. Olsen I. E., et al. BMI curves for preterm infants. *Pediatrics*. 2015; 135:e572–e581.
38. Adamkin, D. H. *Nutritional Strategies for the Very Low Birthweight Infant*. New York: Cambridge University Press, 2009.
39. Anderson, D. M. Nutrition for Preterm Infants. In: Samour, P. Q., & King, K. (Eds.), *Pediatric Nutrition*, 4th ed. Sudbury, MA: Jones & Bartlett Learning, 2012:53–69.
40. Hay, W. W., et al. Workshop summary: Nutrition of the extremely low birth weight infant. *Pediatrics*. 1999; 104:1360–1368.
41. Longo, S., et al. Short–term and long–term sequelae in intrauterine growth retardation (IUGR). *J Matern Fetal Neonatal Med*. 2013; 26(3):222–225.
42. American Congress of Obstetricians and Gynecologists. IUGR (FGR)—Detection and Surveillance. June 28, 2015. Retrieved from American Congress of Obstetricians and Gynecologists website: www.acog/org.
43. Barker, D. The developmental origins of adult disease. *J Am Coll Nutr.* 2004; 23(6 Suppl):588S–595S.
44. Chyi, L. J., et al. School outcomes of later preterm infants: Special needs and challenges for infants born 32 to 36 weeks gestation. *J Pediatr.* 2008; 153:25–31.
45. Hintz, S. R., et al. Changes in neurodevelopmental outcomes at 18 to 22 months corrected age among infants of less than 25 weeks gestational age born in 1993–1999. *Pediatrics*. 2005; 115(6):1645–1651.
46. Franz, A. R., et al. Intrauterine, early neonatal, and postdischarge growth and neurodevelopmental outcome at 5.4 years in extremely preterm infants after intensive neonatal nutrition support. *Pediatrics*. 2009; 123:e101–e109.
47. Clark, R. H., et al. Extrauterine growth restriction remains a serious problem in prematurely born neonates. *Pediatrics*. 2003; 111:986–990.
48. Hans, D. M., et al. Nutritional practices in the neonatal intensive care unit: Analysis of a 2006 neonatal nutrition survey. *Pediatrics*. 2009; 123:51–57.
49. Weaver, L. Rapid growth in infancy: Balancing the interests of the child. *J Pediatr Gastroenterol Nutr.* 2006; 43:428–432.
50. Baylor College of Medicine, Department of Pediatrics, Section on Neonatology. *Guidelines for Acute Care of the Neonate,* 29th ed. Houston, TX: Baylor College of Medicine, 2021.
51. Eicher, P. S. Feeding. In Batshaw, M. L., Roizen, N. J., & Lotrecchiano, G. R. (Eds.), *Children with Disabilities*. Baltimore, MD: Paul H. Brookes, 2007:479–498.
52. Persson, B., et al. Screening for infants with developmental deficits and/or autism. *J Pediatr Nurs*. 2006; 21:313–324.
53. Hayes, D., et al. Pulmonary function outcomes in bronchopulmonary dysplasia through childhood and into adulthood: Implications for primary care. *Prim Care Respir J*. 2011; 20(2):128–133.
54. Glass, R. P., & Wolf, L. Oral-motor Feeding Problems. In Yang, Y., Lucas, B., & Feucht, S. (Eds.), *Nutrition Interventions for Children with special Health Care Needs,* 3rd ed. Olympia, WA: Washington State Department of Health, 2010:93–99.
55. Academy of Nutrition and Dietetics: Nutrition services for individuals with intellectual and developmental disabilities and special health care needs. *Acad Nutr Diet* 2015; 115:593–608.
56. Academy of Nutrition and Dietetics. *Abridged Nutrition Care Process Terminology (NCPT) Reference Manual*. Chicago, IL: Academy of Nutrition and Dietetics, 2018.
57. Barker, D. Human Growth and Disease in Later Life. In: Duggan, C., Watkins, J., & Walker, W. A. (Eds.), *Nutrition in Pediatrics,* 4th ed. Hamilton, ON: B.C. Decker Inc., 2008:305–309.
58. Aamoudse-Moens, C. S., et al. Meta–analysis of neurobehavioral outcomes in very preterm and/or very low birth weight children. *Pediatrics*. 2009; 124(2):717–728.
59. Ehrenkranz, R. A. Nutrition, Growth and Clinical Outcomes. In: Koletzo, B., Poindexter, B., & Uauy R. (Eds.), *Nutritional Care of Preterm Infants*. Basel, Switzerland: Karger, 2014:110:11–26.
60. Bankhead, R., et al. ASPEN enteral nutrition practice recommendations. *J Parenter Enteral Nutr.* 2009; 33(2):122–167.
61. Bhatia, J. Human milk and the premature infant. *Ann Nutr Metab*. 2013; 62(Suppl) 3:8–14.
62. Human Milk Banking of North America. *Best Practice for Expressing, Storing and Handling Human Milk in Hospitals, Homes, and Child Care Settings*. Fort Worth, TX: Human Milk Banking Association of North America, 2019.
63. Schanler, R. J., et al. Randomized trial of donor human milk versus preterm formula as substitutes for mothers' own milk in the feeding of extremely premature infants. *Pediatrics*. 2005; 116:400–406.

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References

64. Forchielli, M. L., & Bines, J. Enteral Nutrition. In Duggan, C., Watkins, J. B., & Walker, W. A. (Eds.), *Nutrition in Pediatrics*, 4th ed. Hamilton, ON: B.C. Decker Inc., 2008:765–775.
65. Steele, C., & Collins, E. (Eds.). *Infant and Pediatric Feedings: Guidelines for Preparation of Human Milk and Formula in Health Care Facilities*, 3rd ed. Chicago, IL: Academy of Nutrition and Dietetics, 2019.
66. Groh-Wargo, S. Gastrointestinal Development. In Groh-Wargo, S., Thompson, M., & Cox, J. H. (Eds.), *Nutritional Care for High–Risk Newborns*, 3rd ed. Chicago, IL: Precept Press, Inc., 2000:209–230.
67. Lawrence, R. A., & Lawrence, R. M. *Breastfeeding: A Guide for the Medical Professional*. Maryland Heights, MO: Elsevier Mosby, 2011.
68. Pinelli, J., & Symington, A. Non-nutritive sucking for promoting physiologic stability and nutrition in preterm infants. *Cochrane Database Syst Rev*. 2005; 19(4):CD001071.
69. Levy, R. J., et al. Birth weight of infants with congenital heart disease. *Am J Dis Child*. 1978; 1:249–254.
70. Gidrewicz, D. A., & Fenton, T. R. A systematic review and meta-analysis of the nutrient content of preterm and term breast milk. *BMC Pediatr*, 2014, 14; 216.
71. Pados B.F., et al. Prevalence of problematic feeding in young children born prematurely: a meta-analysis. *BMC Pediatr*. 2021, 21:110.
72. Centers for Disease Control and Prevention. *Data and Statistics: Spina Bifida*. 2014. https://www.cdc.gov, accessed February 21, 2022.

Chapter 10

1. Center on Hunger, Poverty and Nutrition Policy. *Statement on the Link between Nutrition and Cognitive Development in Children*. Medford, MA: Tufts University, School of Nutrition Science and Policy, 1998.
2. Roberts, M., et al. The effects of nutritional interventions on the cognitive development of preschool-age children: A systematic review. *Nutr*. 2022 Jan 26; 14(3):532. doi: 10.3390/nu14030532. PMID: 35276891; PMCID: PMC8839299.
3. Jiang, Y., et al. Basic facts about low-income children: Children under 6 years, 2013. *National Center for Children in Poverty*. January 2018. Available at www.nncp.org/publications/pub_1095.html, accessed April 24, 2023.
4. The Annie E. Casey Foundation. *2021 KIDS COUNT Data Book*. Baltimore, MD: The Annie E. Casey Foundation, 2021. Available at https://www.acef.org/resources/2021-kids-count-data-book, accessed April 24, 2023.
5. Burns, K., Fox, L., & Wilson, D. Expansions to child tax credit contributed to 46% decline in child poverty since 2020. September 13, 2022. Available at https://www.census.gov/library/stories/2022/09/record-drop-in-child-poverty.html, accessed April 24, 2023.
6. U.S. Department of Health and Human Services, Health Resources and Services Administration, Maternal and Child Health Bureau. *Child Health USA 2011*. Rockville, MD: U.S. Department of Health and Human Services, 2011.
7. U.S. Department of Health and Human Services. *Healthy People 2030*. Washington, DC: U.S. Department of Health and Human Services. Available at https://health.gov/healthypeople, accessed April 24, 2023.
8. Kliegman, R. M., et al. *Nelson's Textbook of Pediatrics*, 20th ed. Philadelphia, PA: Elsevier/Saunders, 2015.
9. Centers for Disease Control and Prevention, National Center for Health Statistics. *CDC growth charts: United States*. Available at www.cdc.gov//growthcharts/cdc_charts.htm, accessed April 25, 2023.
10. Barlow, S. E., Expert Committee. Expert Committee Recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: Summary report. *Pediatrics*. 2007; 120(S4):S164–S192.
11. WHO Multicentre Growth Reference Study Group. *WHO Child Growth Standards: Length/Height-for-Age, Weight-for-Age, Weight-for-Length, Weight-for-Height and Body Mass Index-for-Age: Methods and Development*. Geneva: World Health Organization, 2006. Available at http://www.who.int/childgrowth/standards/technical_report/en/index.html, accessed April 25, 2023.
12. Holt, K., et al. (eds.). *Bright Futures. Nutrition*. Elk Grove Village, IL: American Academy of Pediatrics, 2011.
13. United States Department of Agriculture, MyPlate. Available at www.myplate.gov, accessed April 25, 2023.
14. Satter, E. The feeding relationship: Problems and interventions. *J Pediatr*. 1990; 117:181–189.
15. Johnson, S. L. Children's food acceptance patterns: The interface of ontogeny and nutrition needs. *Nutr Rev*. 2002; 60. https://pubmed.ncbi.nlm.nih.gov/12035867/.
16. Birch, L. L., et al. The variability of young children's energy intake. *N Eng J Med*. 1991; 324:232–235.
17. Walton, K., et al. Time to re-think picky eating?: A relational approach to understanding picky eating. *Int J Behav Nutr Phys Act*. 2017 Dec; 14:1–8.
18. Story, M., & Brown, J. E. Do young children instinctively know what to eat? The studies of Clara Davis revisited. *New Eng J Med*. 1987; 316:103–106.
19. Van den Bree, M. B. M., et al. Genetic and environmental influences on eating patterns of twins ages >50 years. *Am J Clin Nutr*. 1999; 70:456–465.
20. Chess, S., & Thomas, A. Dynamics of individual behavioral development. In M. D. Levine, W. B. Carey, & A. C. Crocker (eds.), *Developmental-Behavioral Pediatrics*. Philadelphia, PA: WB Saunders, 1992:84–94.
21. Birch, L. L., et al. Influences on the development of children's eating behaviours: From infancy to adolescence. January 2007. http://europepmc.org/article/med/19430591.01.
22. Birch, L. L., & Fisher, J. A. Appetite and eating behavior in children. *Pediatr Clinic N Amer*. 1995; 42:931–953.
23. Fisher, J. O., et al. Parental influences on young girls' fruit and vegetable, micronutrient, and fat intakes. *J Amer Diet Assoc*. 2002; 102:58–64.
24. Murray, R. D. Savoring sweet: Sugars in infant and toddler feeding. *Ann Nutr Metab*. 2017; 70(Suppl. 3):38–46.
25. Fisher, J. O., & Birch, L. L. Restricting access to palatable foods affects children's behavioral response, food selection, and intake. *Am J Clin Nutr*. 1999; 69:1264–1272.
26. Connor, S. M. Food-related advertising on preschool television: Building brand recognition in young viewers. *Pediatrics*. 2006; 118:1478–1485.
27. Smith, R., et al. Food marketing influences children's attitudes, preferences and consumption: A systematic critical review. *Nutrients*. 2019 Apr 18; 11(4):875. doi: 10.3390/nu11040875. PMID: 31003489; PMCID: PMC6520952.
28. Muth, M. K., Karns, S. A., & Hayes, M. *Assessing the public health impacts of the Children's Food and Beverage Advertising Initiative: Research Report*. 2021. Healthy Eating Research, Duke Global Health Institute, Duke University
29. Birch, L. L., & Fisher, J. O. Food intake regulation in children, fat and sugar substitutes and intake. *Ann NY Acad Sci*. 1997; 819:194–220.
30. Rolls, B. J., et al. Serving portion size influences 5-year-old but not 3-year-old children's food intake. *J Amer Diet Assoc*. 2000; 100:232–234.
31. Fisher, J. O., et al. Children's bite size and intake of an entrée are greater with large portions than with age-appropriate or self-selected portions. *Am J Clin Nutr*. 2003; 77:1164–1170.
32. Fisher, J. O., & Birch, L. L. Parents' restrictive feeding practices are associated with young girls' negative self-evaluation of eating. *J Amer Diet Assoc*. 2000; 100:1341–1346.
33. Davison, K. K., & Birch, L. L. Weight status, parent reaction, and self-concept in five-year-old girls. *Pediatrics*. 2001; 107:46–53.
34. Ek, A., et al. Associations between parental concerns about preschoolers' weight and eating and parental feeding practices: Results from analyses of the child eating behavior questionnaire, the child feeding questionnaire, and the lifestyle behavior checklist. *PloS one*. 2016 Jan 22; 11(1):e0147257.
35. Abramovitz, B. A., & Birch, L. L. Five-year-old girls' ideas about dieting are predicted by their mothers' dieting. *J Amer Diet Assoc*. 2000; 100:1157–1163.
36. Satter, E. Feeding dynamics: Helping children to eat well. *J Pediatr Health Care*. 1995; 9:178–184.

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References

37. Davis, M. M., et al. Recommendations for prevention of childhood obesity. *Pediatrics*. 2007; 120(Suppl 4):S229–S253.
38. Heller, R. L, et al. A qualitative study of providers' perceptions of parental feeding practices of infants and toddlers to prevent childhood obesity. *BMC Public Health*. 2021 Dec; 21:1–9.
39. National Academy of Sciences, Institute of Medicine, Food and Nutrition Board. Dietary *Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Protein, and Amino Acids*. Washington, DC: National Academy Press, 2005.
40. 2023 Dietary Recommended Intakes for Energy. Available at https://www.nationalacademies.org/our-work-dietary-reference-intakes-for-energy, accessed April 25, 2023.
41. National Academy of Sciences, Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Calcium, and Vitamin D*. Washington, DC: National Academy Press, 2010.
42. National Academy of Sciences, Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc*. Washington, DC: National Academy Press, 2001.
43. Centers for Disease Control and Prevention. Recommendations to prevent and control iron deficiency in the United States. *MMWR Morb Mortal Wkly Rep*. April 3, 1998; 47(RR-03):1–29.
44. Prevalance of anaemia in children aged 6–59 months (%). Updated March 31, 2021. Available at https://www.who.int/data/gho/data/indicators/indicators/indicator-details/GHO/prevelance-of-anemia-in-children-under-5-years-(-), accessed April 25, 2023.
45. Wang, M. Iron deficiency and other types of anemia in infants and children. *Am Fam Phys*. 2016 Feb 15; 93(4):270–278.
46. Baker, R. D., Greer, F. R.; American Academy of Pediatrics Committee on Nutrition. Diagnosis and prevention of iron deficiency and iron deficiency anemia in infants and young children (0 to 3 years). *Pediatrics*. 2010; 126(5): 1040–1050.
47. Dental Carries in Primary Teeth—Children 2–5 years. Oral Health Surveillance Report. Available at https://www.cdc.gov/oralealth/publications/OSHR-2019-summary.html, accessed April 25, 2023.
48. Dye, B. A., et al. *Dental Caries and Sealant Prevalence in Children and Adolescents in the United States 2011–2012*. NCHS Data Brief, No. 191 Hyattsville, MD: National Center for Health Statistics, 2015. Available at www.cdc.gov/nchs/data/databriefs/db191.htm.
49. American Academy of Pediatric Dentistry. Policy on early childhood caries (ECC): Classifications, consequences, and preventive strategies, 2011. Available at http://www.aapd.org/media/Policies_Guidelines/P_ECCClassification.pdf, accessed April 27, 2023.
50. Casamassimo, P. *Bright Futures in Practice: Oral Health* Arlington, VA: National Center for Education in Maternal and Child Health, 1996.
51. American Academy of Pediatrics. *Committee on Nutrition* In Kleinman, R. E., (ed.), *Pediatric Nutrition Handbook*, 8th ed. Elk Grove Village, IL: American Academy of Pediatrics, 2020.
52. Centers for Disease Control and Prevention. Blood lead levels—United States, 1999–2002. *MMWR Morb Mortal Wkly Rep*. 2005; 54(20):513–516.
53. American Academy of Pediatrics, Committee on Environmental Health. Lead exposure in children: Prevention, detection, and management. *Pediatrics*. 2005; 116:1036–1046.
54. Blood Lead Levels in Children: What Parents Need to Know. Sample, J. A., and Xajac, L. updated December 21, 2021. American Academy of Pediatrics Committee on Environmental Health and Climate Change and Section on Hematology/Oncology (Copyright © 2021). Available at https://Healthychildren.org/English/safety-prevention/all-around/Pages/Blood-Lead-Levels-in-Children-What-Parents-NEed-to-Know.aspx, accessed April 26, 2023.
55. Cantor, A.G., et al. Screening for elevated blood lead levels in childhood and pregnancy: Updated evidence report and systematic review for the US Preventive Services Task Force. *JAMA*. 2019 Apr 16; 321(15):1510–1526.
56. CDC updates blood lead level reference level to 3.5ug/dl. Updated December 16, 2022. Available at https://www.cdc.gov/nceh/lead/news/cdc-updates-blood-lead-reference-value.html, accessed April 26, 2023.
57. Advisory Committee on Childhood Lead Poisoning Prevention. Low level lead exposure harms children: A renewed call for primary prevention. Available at http://www.cdc.gov/nceh/lead/acclpp/final_document_030712.pdf, accessed April 26, 2023.
58. Rabbit, M., et al. Understanding the prevalence, severity, and distribution of food insecurity in the United States. *Economic Research Report*. Updated October 17, 2022. Available at www.https://www.ers.usda.gov/amber-waves/2017/september/understanding-the-prevalence-severity-and-distribution-of-food-insecurity-in-the-united-states/, accessed April 26, 2023.
59. Hunger and Poverty in America. Available at https://frac.org/hunger-poverty-america, accessed April 26, 2023.
60. How the US government uses programs like SNAP to combat food insecurity—and why those benefits have decreased. Updated March 28, 2023. Available at https://usafacts.org/articles/what-is-food-insecurity-and-how-dows-the-government-combat-it/, accessed April 26, 2023.
61. Centers for Disease Control and Prevention, National Center for Infectious Diseases, U.S. Department of Health and Human Services. Foodborne Illness. Available at www.cdc.gov/ncidod/diseases/food/index.htm, accessed April 26, 2023.
62. Partnership for Food Safety Education: FightBAC™. Available at www.fightbac.org, accessed April 26, 2023.
63. U.S. Department of Health and Human Services and U.S. Department of Agriculture. *Dietary Guidelines for Americans2020–2025*, 9th ed. Washington, DC: U.S. Government Printing Office, December 2020. Available at https://www.dietaryguidelines.gov/recourses/2020-2025-dietary-guidelines-online-materials, accessed April 24, 2023.
64. National Health and Examination Survey. NCHS Data Brief No. 211, August 2015 Available at www.cdc.gov/nchs/data/databriefs/db211.htm.
65. Krebs, N. F., et al. Assessment of child and adolescent overweight and obesity. *Pediatrics*. 2007; 120(Suppl 4):S193–S228.
66. Spear, B. A., et al. Recommendations for treatment of child and adolescent overweight and obesity. *Pediatrics*. 2007; 120(Suppl 4):S254–S288.Sanyaolu, A., et al. Childhood and adolescent obesity in the United States: A public health concern. Published online December 1, 2019. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6887808/, accessed April 26, 2023.
67. Childhood Obesity Facts: Prevalence of Childhood Obesity in the United States. May 17, 2022. Available at https://www.cdc.gov/obesity/data/childhood.html, accessed April 26, 2023.
68. Spear, B. A., et al. Recommendations for treatment of child and adolescent overweight and obesity. *Pediatrics*. 2007 Dec; 120(Suppl 4): S254-S288.
69. Whitaker, R. C., et al. Early adiposity rebound and the risk of adult obesity. *Pediatrics*. [serial online] 1998; 101:E5. Available at www.pediatrics.org/cgi/content/full/101/3/e5, accessed April 24, 2023.
70. Kang, M. J. The adiposity rebound in the 21st century children: meaning for what?. *Clin Exp Pediatr*. 2018; 61(12):375–380.
71. Gidding, S. S., et al. Implementing American Heart Association pediatric and adult nutrition guidelines: A scientific statement from the American Heart Association Nutrition Committee of the Council on Nutrition, Physical Activity and Metabolism, Council on Cardiovascular Disease in the Young, Council on Arteriosclerosis, Thrombosis and Vascular Biology, Council on Cardiovascular Nursing, Council on Epidemiology and Prevention, and Council for High Blood Pressure Research. *Circulation*. 2009; 119:1161–1175.
72. Kavey, R. W., et al. American Heart Association guidelines for primary prevention of atherosclerotic cardiovascular disease beginning in childhood. *Circulation*. 2003; 107:1562–1566.
73. Gidding, S. S., et al. Dietary recommendations for children and adolescents: A guide for practitioners. Consensus statement from the American Heart Association. *Circulation*. 2005; 112:2061–2075.
74. American Heart Association, Gidding, S. S., et al. Dietary recommendations for children and adolescents: A guide for practitioners. *Pediatrics*. 2006; 117:544–559.

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Editorial review has deemed that any suppressed content does not materially affect the overall learning experience. Cengage Learning reserves the right to remove additional content at any time if subsequent rights restrictions require it.

References

75. Lichtenstein, A. H., et al. Diet and lifestyle recommendations revision 2006: A scientific statement from the American Heart Association Nutrition Committee. *Circulation*. 2006; 114:82–96.
76. Rask-Nissilä, L., et al. Prospective, randomized, infancy-onset trial of the effects of a low-saturated-fat, low-cholesterol diet on serum lipids and lipoproteins before school age: The Special Turku Coronary Risk Factor Intervention Project (STRIP). *Circulation*. 2000; 102:1477–1483.
77. Daniels, S. R., et al. Lipid screening and cardiovascular health in childhood. *Pediatrics*. 2008; 122:198–208.
78. Expert Panel on Integrated Guidelines for Cardiovascular health and Risk Reduction in Children and Adolescents. Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents: Summary Report. *Pediatrics*. 2011; 128:S213–S256.
79. Ervin, R. B., et al. Prevalence of leading types of dietary supplements used in the Third National Health and Nutrition Examination Survey, 1988–1994. *Advance Data from Vital Health Statistics*. No. 349, November 9, 2004.
80. Kavey, R. W., et al. American Heart Association guidelines for primary prevention of atherosclerotic cardiovascular disease beginning in childhood. *Circulation*. 2003; 107:1562–1566.
81. Mishra, S., et al. Dietary supplement use among adults: United States 2017–2018, https://www.cdc.gov/nchs/data/databriefs/db399-H.pdf.
82. Mishra, S., et al. Dietary supplement use in the United States: National Health and Nutrition Examination Survey, 2017–March 2020. National Health Statistics Reports. Available at https://www.cdc.gov/nchs/data/nhsr/nhsr183.pdf, accessed April 18, 2023.
83. Lohse, B., et al. Survey of herbal use by Kansas and Wisconsin WIC participants reveals moderate, appropriate use and identifies herbal education needs. *J Amer Diet Assoc*. 2006; 106:227–237.
84. Yong, D., et al. Use of herbal medicinal products among children and adolescents in Germany. Published online July 2, 2014, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4091953/, accessed April 28, 2023.
85. Academy of Nutrition and Dietetics. Nutrition Guidance for Healthy Children Ages 2 to 11 years. Published February 11, 2015. https://www.eatright.org/food/resources/eatright-infographics/nutrition-guidance-for-healthy-children-ages-2-to-11-years, accessed April 28, 2023.
86. FDA and EPA issue updated advice for fish consumption, U.S. Food and Drug Administration, news release, June 20, 2014. Available at https://www.fda.gov/news-events/press-announcements/fda-and-epa-issue-final -fish-consumption-advice, accessed April 28, 2023.
87. Cleveland Clinic. How much fiber DO children need. Available at https://health.clevelandclinic.org/figuring-dietary-fiber-child-need/, accessed December 30, 2020.
88. Hampl, J. S., et al. The "age + 5" rule: Comparisons of dietary fiber intake among 4- to 10-year-old children. *J Amer Diet Assoc*. 1998; 98:1418–1423.
89. Sibylle, K., et al. What do we know about dietary fiber intake in children and health? The effects of fiber intake on constipation, obesity, and diabetes in children. *Adv Nutr*. January 2012; 3(1):47–53. https://doi.org/10.3945/an.111.001362.
90. Wagner, C. L., Greer, F. R. Section on Breastfeeding and Committee on Nutrition. Prevention of rickets and vitamin D deficiency in infants, children, and adolescents. *Pediatrics*. 2008; 122:1142–1152.
91. Holick, M. F. The D-lightful vitamin D for child health. *JPEN*. 2012 Jan; 36:9S–19S.
92. Greer, F. R., Krebs, N. F., Committee on Nutrition. Optimizing bone health and calcium intakes of infants, children, and adolescents. *Pediatrics*. 2006; 117:578–585.
93. Wang, Y. C., et al. Increasing caloric contribution from sugar-sweetened beverages and 100% fruit juices among U.S. children and adolescents, 1988–2004. *Pediatrics*. 2008; 121:e1604–e1614.
94. Siega-Riz, A. M., et al. Food consumption patterns of infants and toddlers: Where are we now? *J Am Diet Assoc*. 2010; 110:S38–S51.
95. Harnack, L., et al. Soft drink consumption among U.S. children and adolescents: Nutritional consequences. *J Amer Diet Assoc*. 1999; 99:436–441.
96. Sugary Drinks Harm Kids' Health. State of Childhood Obesity. September 3, 2020. Available at https://stateofchildhoodobesity.org/sugary-drinks-harm-kids-health/, accessed April 28, 2023.
97. Sugary Drinks Harm Kids' Health. State of Childhood Obesity. September 3,2020. Available at https://stateofchildhoodobesity.org/sugary-drinks-harm-kids-health/, accessed April 28, 2023.
98. Committee on Nutrition. The use and misuse of fruit juice in pediatrics. *Pediatrics*. 2001 May 1; 107(5):1210–1213.
99. Heyman, M. B., et al. Fruit juice in infants, children, and adolescents: Current recommendations. *Pediatrics*. 2017 Jun 1; 139(6).
100. Butte, N. F. Nutrient intakes of US infants, toddlers, and preschoolers meet or exceed dietary reference intakes. *J Amer Diet Assoc*. 2010; 110:S27–S37.
101. Skinner, J. D., et al. Longitudinal study of nutrient and food intakes of white preschool children aged 24 to 60 months. *J Amer Diet Assoc*. 1999; 99:1514–1521.
102. What We Eat in America, NHANES 2017–2020 Prepandemic. Available at https://www.ars.usda.gov, accessed April 28, 2023.
103. Roess, A. A., et al. Food consumption patterns of infants and toddlers: Findings from the Feeding Infants and Toddlers Study (FITS) 2016. *J Nutr*. 2018 Sep 1; 148(suppl 3): 1525S–1535S. doi: 10.1093/jn/nxy171. PMID: 30247583; PMCID: PMC6126630.
104. Picciano, M. F., et al. Nutritional guidance is needed during dietary transition in early childhood. *Pediatrics*. 2000; 106:109–114.
105. Bowman, S. A., et al. Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. *Pediatrics*. 2004; 113:112–118.
106. Kranz, S., et al. Adverse effect of high added sugar consumption on dietary intake in American preschoolers. *J Pediatr*. 2005; 146:105–111.
107. McConaby, K. L., et al. Food portions are positively related to energy intake and body weight in early childhood. *J Pediatr*. 2002; 140:340–347.
108. Muller, P. Vegan diet in young children. https://pubmed.ncbi.nlm.nih.gov/31991425/. Epub January 28, 2020.
109. American Dietetic Association. Position of the American Dietetic Association: Vegetarian diets. *J Amer Diet Assoc*. 2009; 109: 1266–1282.
110. American Dietetic Association. Position of the American Dietetic Association: Benchmarks for nutrition programs in child-care settings. *J Amer Diet Assoc*. 2005; 105:979–986.
111. Child Care Data Center & State Fact Sheets. Available at https://www.childcareaware.rg/our-issues/research/ccdc, accessed April 28, 2023.
112. American Academy of Pediatrics, American Public Health Association, Health Resources and Services Administration, Maternal and Child Health Bureau. *Caring for Our Children, National Health and Safety Performance Standards: Guidelines for Out-of-Home Child Care Programs*, 2nd ed. Elk Grove Village, IL: American Academy of Pediatrics, 2002.
113. American Academy of Pediatrics, Council on Sports Medicine and Fitness and Council on School Health. Active healthy living: Prevention of childhood obesity through increased physical activity. *Pediatrics*. 2006; 117:1834–1842.
114. Hagan, J. F., et al. (eds.). *Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents*, 3rd ed. Elk Grove Village, IL: American Academy of Pediatrics, 2008.
115. Food Research and Action Center. Impact of the revised WIC food packages on nutrition outcomes and the retail food environment, September 2014. Available at: http://frac.org/pdf/frac_brief_revised_wic_food_package_impact_nutrition_retail.pdf, accessed April 28, 2023.
116. Women, Infants, and Children (WIC). WIC Racial-Ethnic Group Enrollment Data 2012. Available at http://www.fns.usda.gov/wic/wic-racial ethnic-group-enrollment-data-2012, accessed April 28, 2023.
117. U.S. Department of Agriculture. Food and Nutrition Services, WIC. Available at www.usda.gov, accessed April 28, 2023.
118. Rose, D., et al. Household participation in the food stamp and WIC programs increases the nutrient intakes of preschool children. *J Nutr*. 1998; 128:548–555.
119. SNAP is linked with improved nutritional outcomes and lower health care costs. January 17, 2018. Available at https://www.cbpp.org/research/food-assistance/snap-is-linked-with-improved-nutrition-oucomes-and-lower-health-care, accessed April 28, 2023.

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Editorial review has deemed that any suppressed content does not materially affect the overall learning experience. Cengage Learning reserves the right to remove additional content at any time if subsequent rights restrictions require it.

References

120. U.S. Department of Agriculture. Supplemental Nutrition Assistance Program (SNAP). Available at www.fns.usda.gov/pd/supplementalnutrition-assistance-program-snap, accessed April 28, 2023.
121. Ratcliffe, C., et al. How much does the Supplemental Nutrition Assistance Program reduce food insecurity? *Am J Agr Econ*. 2011; 93:1082–1098.

Chapter 11

1. Healthy People 2030 Objectives. Available at https://health.gov/healthypeople, accessed April 24, 2023.
2. Dietary Guidelines for Americans, 2020–2025. Available at https://www.dietaryguidelines.gov/sites/default/files/2020-2025, accessed April 24, 2023.
3. United States Department of Labor. Disability Resources. Available at https://dol.gov/general/topic/disability, accessed April 28, 2023.
4. Kraus, L. Disability Statistics Annual Report. Durham, NH: University of New Hampshire, 2017. Available at https://disabilitycompendium.org/sites/default/files/user-uploads/2016_AnnualReport.pdf, accessed April 26, 2023.
5. Yeargin-Allsopp, M., et al. Epidemiology of developmental disabilities. In Batshaw, M. L., et al. (eds.), *Children with Disabilities*, 6th ed. Baltimore, MD: Paul H. Brookes, 2007:231–243.
6. Children and Youth with Special Health Care Needs. HRSA Maternal & Child Health. NCHS Data Brief. June 2022. Available at https://mchb.hrsa.gov/sites/default/files/mchb/programs-impact/nsch-data-brief-children-youth-special-health-care-needs.pdf, accessed April 28, 2023.
7. Ghandour, R. M., Hirai, A. H., & Kenney, M. K. Children and youth with special health care needs: a profile. *Pediatrics*. 2022 Jun 1; 149(Suppl 7).
8. Staiano, A. Food refusal in toddlers with chronic diseases. *J Ped Gastro Nutr*. 2003; 37:225–227.
9. Council on Children with Disabilities, Section on Developmental Behavioral Pediatrics, Bright Futures Steering Committee, and Medical Home Initiatives for Children with Special Needs Project Advisory Committee. Identifying infants and young children with developmental disorders in the medical home: An algorithm for developmental surveillance and screening. *Pediatrics*. 2006; 118:405–420.
10. Hagan, J. F., et al. (eds.), *Bright Futures: Guidelines for Health Supervision of Infants, Children and Adolescents,* 4th ed. Elk Grove Village, IL: American Academy of Pediatrics, 2017.
11. National Information Center for Children and Youth with Disabilities. General information about disabilities. Available at www.nichcy.org/general.htm, accessed April 29, 2023.
12. Individuals with Disabilities Education Act Sec. 303.13. Early intervention services. Available at https://sites.ed.gov/idea/reg-s/c/a/303.13, accessed April 29, 2023.
13. Trumbo, P., et al. Dietary reference intakes: Vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc. *J Amer Diet Assoc*. 2001; 101:294–301.
14. Institute of Medicine Food and Nutrition Board. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids*. Washington, DC: National Academy Press, 2002.
15. Kleinman, R. E. (ed.), *Pediatric Nutrition Handbook*, 8th ed. Chicago, IL: American Academy of Pediatrics, 2019.
16. Academy of Nutrition and Dietetics. Nutrition Terminology Reference Manual (eNCPT): Dietetics Language for Nutrition Care. Available at http://ncpt.webauthor.com, accessed April 28, 2023.
17. DeVore, J., & Shotton, A. (eds.). *Pocket Guide to Children with Special Health Care and Nutritional Needs*. Chicago, IL: Academy of Nutrition and Dietetics, 2012.
18. Bull, M. J., & the Committee on Genetics. Clinical report: Health supervision for children with Down syndrome. *Pediatrics*. 2011; 128(2):393–406.
19. Polfuss, M., Sawin, K. J., Papanek, P. E., Bandini, L., Forseth, B., Moosreiner, A., Zvara, K., & Schoeller, D. A. Total energy expenditure and body composition of children with developmental disabilities. *Disabil Health J*. 2018 Jul; 11(3):442–446. doi: 10.1016/j.dhjo.2017.12.009. Epub 2017 Dec 28. PMID: 29329773; PMCID: PMC6005723.
20. Zimmerman, J., & Fisher, M. Avoidant/restrictive food intake disorder (ARFID). *Curr Probl Pediatr Adolesc Health Care*. 2017 Apr 1; 47(4):95–103.
21. TEIS (Therapeutic Early Intervention Services in Pennsylvania). What are nutrition services in early intervention? Available at https://www.teis-ei.com, accessed April 29, 2023.
22. Gilliam, J., et al. Nutrition interventions for children with special needs, nutrition screening. https://doh.wa.gov/sites/default/files/legacy/Documents/8100//961-158-CSHCN-NI-en-L.pdf.
23. Ptomey, L. T., & Wittenbrook, W. Position of the Academy of Nutrition and Dietetics: Nutrition services for individuals with intellectual and developmental disabilities and special health care needs. *J Acad Nutri Diet*. 2015 Apr 1; 115(4):593–608.
24. Centers for Disease Control and Prevention. Use of World Health Organization and CDC growth charts for children aged 0–59 months in the United States. *MMWR*. 2010; 59 (No. RR-9):1–15.
25. National Center for Health Statistics. *NCHS Growth Curves for Children 0–19 Years*. U.S. Vital and Health Statistics, Health Resources Administration. Washington, DC: U.S. Government Printing Office, 2000.
26. Nellhaus, G. Composite international and interracial graphs. *Pediatrics*. 1968; 41:106–114.
27. Tarquinio, D. C., Motil, K. J., Hou, W., Lee, H. S., Glaze, D. G., Skinner, S. A., Neul, J. L., Annese, F., McNair, L., Barrish, J. O., & Geerts, S. P. Growth failure and outcome in Rett syndrome: Specific growth references. *Neurology*. 2012 Oct 16; 79(16):1653–1661.
28. Isaacs, J. S., et al. Eating difficulties in girls with Rett syndrome compared with other developmental disabilities. *J Amer Diet Assoc*. 2003; 103(2):224–230.
29. Ashwal, S., et al. Practice parameter: Evaluation of the child with microcephaly (an evidence-based review). Report of the Quality Standards Subcommittee of the American Academy of Neurology and the Practice Committee of the Child Neurology Society. *Neurology*. September 15, 2009; 73(11):887–897.
30. Elias, E. R., Murphy, N. A., & the Council on Children with Disabilities. Home care of children and youth with complex health care needs and technology dependencies. *Pediatrics*. 2012; 129:996–1005.
31. American Academy of Pediatrics. The use and misuse of fruit juice in pediatrics. *Pediatrics*. 2001; 107:1210–1213.
32. Heyman, M. B., Abrams, S. A., Heitlinger, L. A., Cabana, M. D., Gilger, M. A., Gugig, R., Hill, I. D., Lightdale, J. R., Daniels, S. R., Corkins, M. R., & de Ferranti, S. D. Fruit juice in infants, children, and adolescents: Current recommendations. *Pediatrics*. 2017 Jun 1; 139(6):e20170967.
33. Ruottinen, S., et al. High sucrose intake is associated with poor quality of diet and growth between 13 months and 9 years of age: The Special Turku Coronary Risk Factor Intervention Project. *Pediatrics*. 2008; 121:e1676–e1685.
34. Council on Children with Disabilities. Role of the medical home in family centered early intervention services. *Pediatrics*. 2007; 120:1153–1158.
35. Ficicioglu, C., & An Haack, K. Failure to thrive: When to suspect inborn errors of metabolism. *Pediatrics*. 2009; 124(3):972–979.
36. Franceschi, R., Rizzardi, C., Maines, E., Liguori, A., Soffiati, M., & Tornese, G. Failure to thrive in infant and toddlers: A practical flowchart-based approach in a hospital setting. *Ital J Pediatr*. 2021 Dec; 47(1):1–8.
37. Kellogg, N. D., & the Committee on Child Abuse and Neglect. Evaluation of suspected child physical abuse. *Pediatrics*. 2007; 119:1232–1241.
38. Berkovitch, M., et al. Copper and zinc blood levels among children with nonorganic failure to thrive. *J Clin Nutr*. 2003; 22(2):183–186.
39. Boyle, E. M., et al. Effects of gestational age at birth on health outcomes at 3 and 5 years of age: Population-based cohort study. *BMJ*. 2012; 344:e896.
40. Niewinski, M. M. Advances in celiac disease and gluten-free diet. *J Amer Diet Assoc*. 2008; 108:661–672.
41. Sahin Y. Celiac disease in children: A review of the literature. *World J Clin Pediatr*. 2021 Jul 7; 10(4):53.

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References

42. Autism and Developmental Disabilities Monitoring Network Surveillance Year 2008 Principal Investigators. Prevalence of autism spectrum disorders—Autism and developmental monitoring network, 14 sites, United States, 2008. *MMWR*. 2012; 61(SS03):1–19.
43. Johnson, C. P., Myers, S. M., & Council on Children with Disabilities. American Academy of Pediatrics Policy Clinical Report: Identification on evaluation of children with autism spectrum disorder. *Pediatrics*. 2007; 120:1183–1215.
44. About ASD. Available at www.cdc.gov /ncbddd/autism/facts.html, accessed June 20, 2015.
45. Marí-Bauset, S., et al. Evidence of the gluten-free and casein-free diet in autism spectrum disorders: A systematic review. *J Child Neurol*. December 2014; 29(12):1718–1727.
46. Mandal, A. Cerebral palsy prevalence in the United States. February 26, 2019. Available at https://www.news-medical.net/health /Cerebral-Palsy-Prevelance.aspx, accessed April 29, 2023.
47. Bell, K. L., & Samson-Fang, L. Nutritional management of children with cerebral palsy. *Eur J Clin Nutr*. December 2013; 67(Suppl 2):S13–S16.
48. Asthma Facts. United States Environmental Protection Agency. June 2022. EPA-402-F-04-019. Available at https://www.epa.gov /sites/default/files/2021-04/documents /asthma_fact_sheet.pdf, accessed April 29, 2023.
49. Asthma. Health, United States, 2020–2021. Available at https://www.cdc.gov/nchs/hus /topics/asthma.htm, accessed April 30, 2023.
50. Asthma Facts. Asthma Foundation of America. Available at https://aafa.org/asthma /asthma-facts, accessed April 30, 2023.
51. Most Recent National Asthma Data. December 13, 2022. Available at https: //www.cdc.gov/asthma/most_recent _national_asthma_data.htm, accessed April 29, 2023.
52. Thiara, G., & Goldman, R. D. Milk consumption and mucus production in children with asthma. *Can Fam Physician*. February 2012; 58:165–166.
53. Lang, J. E. Obesity and asthma in children: Current and future therapeutic options. *Pediatric Drugs*. 2014; 16:179–188.
54. Strueby, L., & Thébaud, B. Advances in bronchopulmonary dysplasia. *Expert Rev Respir Med*. June 2014; 8(3):327–338.
55. Hayes, D., Jr., et al. Pulmonary function outcomes in bronchopulmonary dysplasia through childhood and into adulthood: Implications for primary care. *Prim Care Respir J*. 2011; 20(2):128–133.
56. Stroustrup, A., & Trasande, L. Epidemiological characteristics and resource use in neonates with bronchopulmonary dysplasia: 1993–2006. *Pediatrics*. 2010; 125:291–297.
57. U.S. Department of Health and Human Services, National Institutes of Health, National Institute of Allergy and Infectious Diseases. *Guidelines for the Diagnosis and Management of Food Allergy in the United States*. Washington, DC: U.S. Government Printing Office, 2010. NIH Publication No. 11-7700.
58. Abrams, E. M., & Sicherer, S. H. Diagnosis and management of food allergy. *CMAJ*. 2016 Oct 18; 188(15):1087–1093.
59. Thomas, D. W., Greer, F. R., & American Academy of Pediatrics Committee on Nutrition Section on Gastroenterology, Hepatology, and Nutrition. Clinical report: Probiotics and prebiotics in pediatrics. *Pediatrics*. 2010; 126:1217–1231.
60. Ball, S. D., et al. Dietary supplement use is prevalent among children with a chronic illness. *J Amer Diet Assoc*. 2005; 105:78–84.
61. National Institutes of Medicine, National Center of Complementary and Alternative Medicine. Patterns of Complementary and Alternative Medicine Use in Children. Available at http://nccam.nih.gov/health/ children#patterns, accessed June 10, 2015.
62. National Down Syndrome Society. Alternative therapies. Available at www .ndss.org/en/Healthcare/Alternative -Therapies, accessed June 15, 2015.
63. Boutaina Z., et al. A hidden side of the Covid-19 pandemic in children: The double burden in of undernutrition and overnutrition. Available at https://equityhealthj .biomedcentral.com/articles/10.1186 /s12939-021-01390-w.
64. COVID-19 Program Flexibilities and Adjustments. https://www.fns.usda.gov /coronavirus#:~:text=Supplemental%20 Nutrition%20Assistance%20Program&text =Pandemic%20EBT%3A%20FNS%20is %20allowing,purchasing%20to%20support %20social%20distancing, accessed April 30, 2023.
65. Akseer, N., Kandru, G., Keats, E. C., & Bhutta, Z. A. COVID-19 pandemic and mitigation strategies: Implications for maternal and child health and nutrition. *Am J Clin Nutr*. 2020 Aug 1; 112(2):251–256.
66. Maternal and Child Health Bureau, Health and Human Services. LEND program. Available at http://mchb.hrsa.gov/html/drte .html, accessed April 30, 2023.
67. Public Law 109–416 109th Congress. Combating Autism Act of 2006. Available at www.congress.gov/109/plaws/publ416 /PLAW-109publ416.pdf, accessed April 30, 2023.

Chapter 12

1. Holt, K., et al. (Eds.). *Bright Futures Nutrition*. Elk Grove Village, IL: American Academy of Pediatrics, 2011.
2. Adolphus, K., et al. The effects of breakfast on behaviour and academic performance in children and adolescents. *Front Hum Neurosci*. 2013; 7:425.
3. Child Population. Available at https://www .childstats.gov/americaschildren/tables /pop1.asp, accessed March 26, 2022.
4. Health Resources and Services Administration and Maternal and Child Health Bureau. National Survey of Children's Health. Available at https://www.childhealthdata .org/learn-about-the-nsch/NSCH, accessed March 26, 2022.
5. Ogden, C. L., et al. Prevalence of obesity and trends in body mass index among US adolescents, 1999–2010. *JAMA*. 2012; 307(5):483–490.
6. Office of Disease Prevention and Health Promotion. U.S. Department of Health and Human Services. *Healthy People 2030*. Washington, DC: U.S. Department of Health and Human Services. Available at www .HealthyPeople.gov, accessed March 22, 2022.
7. Kliegman, R. M., et al. (Eds.). *Nelson Textbook of Pediatrics*, 19th ed. Philadelphia, PA: Elsevier/Saunders, 2011.
8. Centers for Disease Control and Prevention, National Center for Health Statistics. CDC growth charts: United States. Available at http://www.cdc.gov/growthcharts/cdc _charts.htm, accessed February 25, 2018.
9. Troiano, R. P., & Flegal, K. M. Overweight children and adolescents: Description, epidemiology, and demographics. *Pediatrics*. 1998; 101:497–504.
10. Barlow, S. E. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: Summary report. *Pediatrics*. 2007; 120:S164–S192.
11. Krebs, N. F., et al. Assessment of child and adolescent overweight and obesity. *Pediatrics*. 2007; 120:S193–S228.
12. Becker, P. J., et al. Consensus Statement of the Academy of Nutrition and Dietetics/ American Society for Parenteral and Enteral Nutrition: Indicators recommended for identification and documentation of pediatric malnutrition (undernutrition). *J Acad Nutr Diet*. 2014; 114:1988–2000.
13. de Oris, M., et al. Development of a WHO growth reference for school-aged children and adolescents. *Bull World Health Organ*. 2007; 85:660–667.
14. Dietz, W. H. Critical periods in childhood for the development of obesity. *Am J Clin Nutr*. 1994; 59:955–959.
15. Hughes, A. R., et al. Timing of adiposity rebound and adiposity in adolescence. *Pediatrics*. 2014; 134:e1354–e1361.
16. Satter, E. Feeding dynamics: Helping children to eat well. *J Pediatr Health Care*. 1995; 9:178–184.
17. Larson, N., Fulkerson, J. A., Berge, J. M., Slsenberg, M. E., & Neumark-Sztainer, D. Do parents perceive that organized activities interfere with family meals? Associations between parent perceptions and aspects of the household eating environment. *J Acad Nutr Diet*. 2020; 120(3):414–423.
18. Trofholz, A. C., Tate, A. D., Draxten, M. L., Rowley, S. S, Schulte, A. K., Neumark-Sztainer, D., MacLehose, R. F., & Berge, J. M. What's being served for dinner? An exploratory investigation of the associations between the healthfulness of family meals and child dietary intake. *J Acad Nutr Diet*. 2017; 117:102–109.

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Editorial review has deemed that any suppressed content does not materially affect the overall learning experience. Cengage Learning reserves the right to remove additional content at any time if subsequent rights restrictions require it.

References

19. Dallacker, M., et al. The frequency of family meals and nutritional health in children: A meta-analysis. *Obesity Rev*. 2018; 19(5):638–653.
20. Ragelienė, T., & Grønhøj, A. (2020). The influence of peers' and siblings' on children's and adolescents' healthy eating behavior. A systematic literature review. *Appetite*, *148*, 104592. https://doi-org.ezproxy2.library.drexel.edu/10.1016/j.appet.2020.104592.
21. Batada, A., et al. Nine out of 10 food advertisements shown during Saturday morning children's television programming are for foods high in fat, sodium, or added sugars, or low in nutrients. *J Amer Diet Assoc*. 2008; 108:673–678.
22. U.S. Department of Agriculture. *MyPlate*. Available at www.MyPlate.gov, accessed March 2022.
23. Russell, S. J., Croker, H., & Viner, R. M. The effect of screen advertising on children's dietary intake: A systematic review and meta-analysis. *Obesity reviews: An official journal of the International Association for the Study of Obesity*. 2019; 20(4):554–568. https://doi-org.ezproxy2.library.drexel.edu/10.1111/obr.12812.
24. Boyland, E. J., Nolan, S., Kelly, B., Tudur-Smith, C., Jones, A., Halford, J. C., & Robinson, E. Advertising as a cue to consume: A systematic review and meta-analysis of the effects of acute exposure to unhealthy food and nonalcoholic beverage advertising on intake in children and adults. *Am J Clin Nutr*. 2016; 103(2):519–533. https://doi-org.ezproxy2.library.drexel.edu/10.3945/ajcn.115.120022.
25. Mc Carthy, C. M., de Vries, R., & Mackenbach, J. D. The influence of unhealthy food and beverage marketing through social media and advergaming on diet-related outcomes in children—A systematic review. *Obesity reviews: An official journal of the International Association for the Study of Obesity*. 2022; e13441. Advance online publication. https://doi-org.ezproxy2.library.drexel.edu/10.1111/obr.13441.
26. Sadeghirad, B., Duhaney, T., Motaghipisheh, S., Campbell, N. R., & Johnston, B. C. Influence of unhealthy food and beverage marketing on children's dietary intake and preference: A systematic review and meta-analysis of randomized trials. *Obesity reviews: An official journal of the International Association for the Study of Obesity*. 2016; 17(10):945–959. Available at https://doi-org.ezproxy2.library.drexel.edu/10.1111/obr.12445.
27. Dixon, H., Niven, P., Scully, M., & Wakefield, M. Food marketing with movie character toys: Effects on young children's preferences for unhealthy and healthier fast food meals. *Appetite*. 2017; 117:342–350. https://doi-org.ezproxy2.library.drexel.edu/10.1016/j.appet.2017.07.014.
28. Radesky, J., Chassiakos, Y., Ameenuddin, N., Navsaria, D., & Council on Communication and Media. Digital Advertising to Children. *Pediatrics*. 2020; 146(1):e20201681. https://doi-org.ezproxy2.library.drexel.edu/10.1542/peds.2020-1681.
29. Duffey, K. J., & Popkin, B. M. Causes of increased energy intake among children in the US, 1977–2010. *Am J Prev Med*. 2013; 44(2):e1–e8.
30. Piernas, C., & Popkin, B. M. Food portion patterns and trends among US children and their relationship to total eating occasion size, 1977–2006. *J Nutr*. 2011; 141(6):1159–1164.
31. Wang, D., et al. Snacking patterns in children: A comparison between Australia, China, Mexico, and the U.S. *Nutrients*. 2018; 10:E198.
32. U.S. Department of Agriculture and U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2020-2025*, 9th ed. December 2020. Available at DietaryGuidelines.gov.
33. Birch, L. L., & Fisher, J. O. Food intake regulation in children, fat and sugar substitutes and intake. *Ann NY Acad of Sci*. 1997; 819:194–220.
34. Rodgers, R. F., et al. Maternal feeding practices predict weight gain and obesogenic eating behaviors in young children: A prospective study. *Int J Behav Nutr Phys Act*. 2013; 10:24.
35. Bergmeier, H., et al. Associations between child temperament, maternal feeding practices and child body mass index during the preschool years: A systematic review of the literature. *Obes Rev*. 2014; 15(1):9–18.
36. Anzman, S. L., & Birch, L. L. Low inhibitory control and restrictive feeding practices predict weight outcomes. *J Pediatr*. 2009; 155(5):651–656.
37. Birch, L. L., & Fisher, J. O. Mothers' child-feeding practices influence daughters' eating and weight. *Amer J Clin Nutr*. 2000; 71:1054–1061.
38. Birch, L. L., & Fisher, J. A. Appetite and eating behavior in children. *Pediatr Clin North Am*. 1995; 42:931–953.
39. Birch, L. L. Psychological influences on the childhood diet. *J Nutr*. 1998; 128:407S–410S.
40. Fisher, J. O., & Birch, L. L. Parents' restrictive feeding practices are associated with young girls' negative self-evaluation of eating. *J Amer Diet Assoc*. 2000; 100:1341–1346.
41. Birch, L. L., & Fisher, J. O. Development of eating behaviors among children and adolescents. *Pediatrics* 1998; 101:539–549(s).
42. Easter, A., et al. A longitudinal investigation of nutrition and dietary patterns in children of mothers with eating disorders. *J Pediatr*. 2013; 163:173–178.
43. Cachelin, F., et al. Does ethnicity influence body-size preference? A comparison of body image and body size. *Obesity Research*. 2002; 10:158–166.
44. National Academy of Sciences, Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Protein, and Amino Acids*. Washington, DC: National Academy Press, 2005.
45. U.S. Department of Health and Human Services and U.S. Department of Agriculture. Dietary Guidelines for Americans, 2015, 8th ed. Available at https://health.gov/dietaryguidelines/2015/guidelines/, accessed February 26, 2018.
46. National Academy of Sciences, Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Calcium, and Vitamin D*. Washington, DC: National Academy Press, 2010.
47. National Academy of Sciences, Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc*. Washington, DC: National Academy Press, 2001.
48. American Academy of Pediatrics, Committee on Nutrition. *Pediatric Nutrition Handbook*, 8th ed. Kleinman, R. E. & Greer, F. R. (Eds.). Elk Grove Village, IL: American Academy of Pediatrics, 2020.
49. Centers for Disease Control and Prevention. Recommendations to prevent and control iron deficiency in the United States. *MMWR*. April 3, 1998; 47:RR-03, 1–29.
50. Casamassimo, P., & Holt K. (Eds.). *Bright Futures in Practice: Oral Health—Pocket Guide*, 2nd ed. Washington, DC: National Maternal and Child Oral Health Resource Center, 2014.
51. Slining, M. S., et al. Trends in food and beverage sources among U.S. children and adolescents: 1989–2010. *J Acad Nutr Diet*. 2013; 113:1683–1694.
52. Freedman, D. S., et al. The relation of overweight to cardiovascular risk factors among children and adolescents: The Bogalusa Heart Study. *Pediatrics*. 1999; 103:1175–1182.
53. Hoelscher, D. M., et al. Position of the Academy of Nutrition and dietetics: Interventions for the prevention and treatment of pediatric overweight and obesity. *J Acad Nutr Diet*. 2013; 113:1375–1394.
54. Skinner, A. C., et al. Prevalence of obesity and severe obesity in US children, 1999–2016. *Pediatrics*. 2018; 141(3):e20173459.
55. Ogden, C. L., et al. Prevalence of childhood and adult obesity in the United States, 2011–2012. *JAMA*. 2014; 311(8):806–814.
56. Freedman, D. S., et al. Cardiovascular risk factors and excess adiposity among overweight children and adolescents: The Bogalusa Heart Study. *J Pediatr*. 2007; 150:12–17.
57. Dietz, W. H. Health consequences of obesity in youth: Childhood predictors of adult disease. *Pediatrics*. 1998; 101:518S–525S.
58. Lawrence, J. M., Divers, J., Isom, S., Saydah, S., Imperatore, G., Pihoker, C., Marcovina, S. M., Mayer-Davis, E. J., Hamman, R. F., Dolan, L., Dabelea, D., Pettitt, D. J., Liese, A. D., & SEARCH for Diabetes in Youth Study Group. Trends in Prevalence of Type 1 and Type 2 Diabetes in Children and Adolescents in the U.S., 2001–2017. *JAMA*. 2021; 326(8):717–727. doi: 10.1001/jama.2021.11165. Erratum in: *JAMA*. 2021; 326(13):1331. PMID: 34427600; PMCID: PMC8385600.

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References

59. American Diabetes Association. Type 2 diabetes in children and adolescents. *Pediatrics*. 2000; 105:671–680.
60. Dietz, W. H. Childhood weight affects adult morbidity and mortality. *J Nutr.* 1998; 128:411S–414S.
61. Llewellyn, A., et al. Childhood obesity as a predictor of morbidity in adulthood: A systematic review and meta-analysis. *Obesity Rev*. 2016; 17:56–57.
62. Freedman, D. S., et al. BMI rebound, childhood height and obesity among adults: The Bogalusa Heart study. *Int J Obes Relat Metab Disord*. 2001; 25:543–549.
63. Strauss, R. S., Knight, J. Influence of the home environment on the development of obesity in children. *Pediatrics*. [Serial online] 1999; 103:e85.
64. Whitaker, R. C., et al. Predicting obesity in young adulthood from childhood and parental obesity. *New Eng J Med*. 1997; 337:869–873.
65. Dowda, M., et al. Environmental influences, physical activity, and weight status in 8- to 16-year-olds. *Arch Pediatr Adolesc Med*. 2001; 155:711–717.
66. Office of Disease Prevention and Health Promotion. U.S. Department of Health and Human Services. Leading health indicators. Available at https://www.healthypeople.gov/2020/Leading-Health-Indicators, accessed March 26, 2022.
67. American Academy of Pediatrics, Council on Communications and Media. Policy Statement—Children, adolescents, obesity and the media. *Pediatrics*. 2011; 128:201–208.
68. American Academy of Pediatrics, Council on Communications and Media. Policy Statement—Media use in school-age children and adolescents. *Pediatrics*. 2016; 138(5):e20162592.
69. American Academy of Pediatrics. Media Use Plan. Available at www.healthychildren.org/English/media/Pages/default.aspx#wizard, accessed March 4, 2018.
70. De Jong, E., et al. Association between TV viewing, computer use, and overweight, determinants and competing activities of screen time in 4- to 13-year-old children. *Int J Obes*. 2013; 37(1):47–53.
71. Klesges, R. C., et al. Effects of television on metabolic rate: Potential implications for childhood obesity. *Pediatrics*. 1993; 91:281–286.
72. Wiecha, J. L., et al. When children eat what they watch; impact of television viewing on dietary intake in youth. *Arch Pediatr Adolesc Med*. 2006; 160(4):436–442.
73. Spear, B. A., et al. Recommendations for treatment of child and adolescent overweight and obesity. *Pediatrics*. 2007; 120:S254–S288.
74. Davis, M. M., et al. Recommendations for prevention of childhood obesity. *Pediatrics*. 2007; 120:S229–S253.
75. Kirk, S., Ogata, B., Wichert, E., Handu, D., & Rozga, M. Treatment of pediatric overweight and obesity: Position of the Academy of Nutrition and Dietetics based on an umbrella review of systematic reviews. 2022; 122(4):848–861.
76. Lichtenstein, A. H., et al. Diet and lifestyle recommendations revision 2006: A scientific statement from the American Heart Association Nutrition Committee. *Circulation*. 2006; 114:82–96.
77. Daniels, S. R., Greer F. R.; and American Academy of Pediatrics, Committee on Nutrition. Lipid screening and cardiovascular health in childhood. *Pediatrics*. 2008; 122(1):198–208.
78. Gidding, S. S., et al. Implementing American Heart Association pediatric and adult nutrition guidelines: A scientific statement from the American Heart Association Nutrition Committee of the Council on Nutrition, Physical Activity and Metabolism, Council on Cardiovascular Disease in the Young, Council on Arteriosclerosis, Thrombosis and Vascular Biology, Council on Cardiovascular Nursing, Council on Epidemiology and Prevention, and Council on High Blood Pressure Research. *Circulation*. 2009; 119:1161–1175.
79. Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents: summary report. *Pediatrics*. 2011; 128:S213–S256.
80. Black, L. I., et al. Use of complementary health approaches among children aged 4–17 years in the United States: National Health Interview Survey, 2007–2012. *Natl Health Stat Rep*. 2015; 78:1–19.
81. Kranz, S., et al. What do we know about dietary fiber intake in children and health? The effects of fiber intake on constipation, obesity, and diabetes in children. *Adv Nutr*. 2012; 3(1):47–53.
82. Dwyer, J. T. Dietary fiber for children: How much? *Pediatrics*. 1995; 96:1019S–1022S.
83. Golden, N. H., Abrams, S. A., and American Academy of Pediatrics, Committee on Nutrition. Optimizing bone health in children and adolescents. *Pediatrics*. 2014; 134:e1229–e1243.
84. Heyman, M. B., & American Academy of Pediatrics, Committee on Nutrition. Lactose intolerance in infants, children, and adolescents. *Pediatrics*. 2006; 118:1279–1286.
85. American Academy of Pediatrics. Committee on Nutrition and the Council on Sports Medicine and Fitness. Sports drinks and energy drinks for children and adolescents: Are they appropriate? *Pediatrics*. 2011; 127:1182–1189.
86. American College of Sports Medicine, Sawka, M. N., et al. American College of Sports Medicine position statement: Exercise and fluid replacement. *Med Sci Sports Exerc*. 2007; 39:377–390.
87. Ludwig, D. S., et al. Relation between consumption of sugar-sweetened drinks and childhood obesity: A prospective, observational analysis. *Lancet*. 2001; 357:505–508.
88. Wang, V. C., et al. Increasing caloric contribution from sugar-sweetened beverages and 100% fruit juices among U.S. children and adolescents, 1988–2004. *Pediatrics*. 2008; 121:e1604–e1614, accessed July 2012.
89. Marriott, B. P., Hunt, K. J., Malek, A. M., & Newman, J. C. Trends in intake of energy and total sugar from sugar-sweetened beverages in the United States among children and adults, NHANES 2003–2016. *Nutrients*. 2019; 11(9):2004. https://doi-org.ezproxy2.library.drexel.edu/10.3390/nu11092004.
90. Rampersaud, G. C., et al. National survey beverage consumption data for children and adolescents indicate the need to encourage a shift toward more nutritive beverages. *J Am Diet Assoc*. 2003; 97–100.
91. Bowman, S. A., et al. Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. *Pediatrics*. 2004; 113:112–118.
92. American Dietetic Association. Position of the American Dietetic Association: Use of nutritive and nonnutritive sweeteners. *J Acad Nutr Diet*. 2012; 112:739–758.
93. Guenther, P. M., et al. Update of the Healthy Eating Index: HEI-2010. *J Acad Nutr Diet*. 2013; 113(4):569–580.
94. Kittler, P. G., et al. *Food and Culture*, 6th ed. Belmont, CA: Wadsworth/Thomson Learning, 2011.
95. Cullum-Dugan, D., & Pawlak, R. Position of the Academy of Nutrition and Dietetics: Vegetarian diets. *J Acad Nutr Diet*. 2015; 115:801–810.
96. Messina, V., & Mangel, A. R. Considerations in planning vegan diets: Children. *J Amer Diet Assoc*. 2001; 101:661–669.
97. American Academy of Pediatrics, Council on Sports Medicine and Fitness and Council on School Health. Active healthy living: prevention of childhood obesity through increased physical activity. *Pediatrics*. 2006; 117:1834–1842.
98. National Association for Sport and Physical Education. *Comprehensive School Physical Activity Programs*. Reston, VA: National Association for Sport and Physical Education, 2008. Available at www.shapeamerica.org/cspap/resources.cfm.
99. Centers for Disease Control and Prevention. Comprehensive Schools Physical Activity Program. Available at https://www.cdc.gov/healthyschools/physicalactivity/index.htm, accessed March 24, 2022.
100. Centers for Disease Control and Prevention. School health guidelines to promote healthy eating and physical activity. *MMWR*. 2011; 60(No. RR-5):28–33.
101. Frehlich, L., Christie, C. D., Ronksley, P. E., Turin, T. C., Doyle-Baker, P., & McCormack, G. R. The neighbourhood built environment and health-related fitness: A narrative systematic review. *Int J Behav Nutr Phys Act*. 2022 Sep 24; 19(1):124. doi: 10.1186/s12966-022-01359-0. PMID: 36153538; PMCID: PMC9509561.
102. Trost, S. G., et al. Physical activity and determinants of physical activity in obese and non-obese children. *Int J Obesity*. 2001; 25:822–829.
103. Centers for Disease Control and Prevention. Physical activity: Equitable and inclusive access. Available at https://www.cdc.gov

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References

/physicalactivity/community-strategies/equitable-and-inclusive-access.html, accessed January 25, 2023.

104. American Academy of Pediatrics, Committee on Nutrition and Council on Sports Medicine and Fitness. Clinical report—sports drinks and energy drinks for children and adolescents: Are they appropriate? *Pediatrics*. 2011; 127(6):1182–1189.
105. Hayes, D., Contento, I. R., & Weekly, C. (2018). Position of the Academy of Nutrition and Dietetics, Society for Nutrition Education and Behavior, and School Nutrition Association: Comprehensive Nutrition Programs and Services in Schools. *J Acad Nutr and Diet*, *118*(5), 913–919. https://doi-org.ezproxy2.library.drexel.edu/10.1016/j.jand.2018.03.005.
106. United States Department of Agriculture, Team Nutrition. Local School Wellness Policy. 2015. Available at www.fns.usda.gov/tn/local-school-wellness-policy, accessed May 1, 2015.
107. Celebuski, C., & Farris, E. Nutrition education in public elementary school classrooms, K–5. Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement, 2000. NCES 2000–040. Available at http://nces.ed.gov/surveys/frss/publications/2000040/, accessed August 17, 2018.
108. Fox, M. K., et al. Availability and consumption of competitive foods in U.S. public schools. *J Amer Diet Assoc*. 2009; 109:S57–S66.
109. American Academy of Pediatrics, Committee on School Health. Soft drinks in schools. *Pediatrics*. 2004; 113:152–154.
110. American Academy of Pediatrics, Council on School Health and Committee on Nutrition. Policy Statement: Snacks, sweetened beverages, added sugars, and schools. *Pediatrics*. 2015; 135:575–583.
111. USDA Food and Nutrition Services. Smart Snacks in Schools. Available at https://www.fns.usda.gov/cn/smart-snacks-school, accessed March 26, 2022.
112. Centers for Disease Control and Prevention. *School Health Index: A Self-assessment and Planning Guide, Elementary School Version*. Atlanta, GA: 2014. Available at www.cdc.gov/Healthyyouth/SHI/pdf/Elementary-Total-2014-Tagged_508.pdf, accessed August 17, 2018.
113. Academy of Nutrition and Dietetics. Position of the Academy of Nutrition and Dietetics: Child and adolescent federally-funded nutrition assistance program. *J Acad Nutr Diet*. 2018; 118:1490–1497.
114. U.S. Department of Agriculture, Food and Nutrition Service. 7 CFR Parts 210 and 220. Nutrition Standards in the National School Lunch and School Breakfast Programs; Final Rule. *Federal Register*. 2012; 77(17).
115. Johnson, D. B., et al. Effect of the Healthy, Hunger-Free Kids Act on the nutritional quality of meals selected by students and school lunch participation rates. *JAMA Pediatr*. 2016; 170(1):e153918.
116. Vaudrin, N., et al. Impact of the 2010 US Healthy, Hunger-Free Kids Act on school breakfast and lunch participation rates between 2008 and 2015. *Am J Pub Health*. 2018; 108:84–86.
117. United States Department of Agriculture, Food and Nutrition Service. *Farm to School Program: Fact Sheet: Research Shows Farm to School Works*. Washington, DC: United States Department of Agriculture, 2016. Available at www.fns.usda.gov/farmtoschool/research-shows-farm-school-works, accessed March 18, 2018.
118. Kropp, J. D., et al. A plate waste evaluation of the *Farm to School* program. *J Nutr Educ Behav*. 2018; 50(4):332–339.
119. Food and Nutrition Service, United States Department of Agriculture. School Meals. Available at https://www.usda.gov/coronavirus/school-meals, accessed March 26, 2022.

Chapter 13

1. United States Department of Education, Office of Special Education and Rehabilitative Services. About IDEA. Available at https://sites.ed.gov/idea/about-idea/, accessed March 28, 2022.
2. U.S. Department of Education, Office of Special Education and Rehabititative Services. A Guide to the Individualized Education Program. Available at www2.ed.gov/parents/needs/speced/iepguide/iepguide.pdf, accessed March 28, 2022.
3. Autism and Developmental Disabilities Monitoring Network Surveillance Year 2010 Principal Investigators. Prevalence of autism spectrum disorders among children aged 8 years—Autism and developmental disabilities monitoring network, 11 sites, United States, 2010. *MMWR*. 2014; 63(SS02):1–21.
4. Health Resources and Service Administration, Maternal and Child Health Bureau. NSCH Data Brief for Children with Special Health Care Needs. Available at https://mchb.hrsa.gov/data-research/national-survey-childrens-health, accessed June 10, 2022.
5. United States Department of Education, National Center for Education Statistics. Children and youth with disabilities. Students with disabilities. Available at https://nces.ed.gov/fastfacts/display.asp?id=64, accessed March 28, 2022.
6. National Academy of Sciences, Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Protein, and Amino Acids*. Washington, DC: National Academy Press, 2005.
7. Kleinman, R. E., Greer, F. R. eds. *Pediatric Nutrition Handbook*, 8th ed. Chicago, IL: American Academy of Pediatrics, 2020.
8. Corkins, K. G., and Wittenbrook, W. (Eds.). *Academy of Nutrition and Dietetics Pocket Guide to Children with Special Health Care and Nutritional Needs, 2nd edition*. Chicago, IL: Academy of Nutrition and Dietetics, 20122021.
9. Healthy People 2020 Objectives. Available at http://www.healthypeople.gov/2020/topicsobjectives2020, accessed August 17, 2018. Office of Disease Prevention and Health Promotion. U.S. Department of Health and Human Services. *Healthy People 2030*. Washington, DC: U.S. Department of Health and Human Services. Available at www.HealthyPeople.gov, accessed March 22, 2022.
10. Prader–Willi Syndrome. January, 2018. Available at www.mayoclinic.com/health/prader-willi-syndrome/DS00922, accessed August 17, 2018.
11. Schertz, M., et al. Predictors of weight loss in children with attention deficit hyperactivity disorder treated with stimulant medication. *Pediatr*. 1996; 98:763–769.
12. Parrish, C. R. Nutritional assessment and intervention in cerebral palsy. *Nutr Issues Gastroenterol*. 2011; series 92.
13. U.S. Department of Health and Human Services, National Institutes of Health, National Institute of Allergy and Infectious Diseases. *Guidelines for the diagnosis and management of food allergy in the United States*. Washington, DC: U.S. Government Printing Office, NIH Publication No 11-7700, 2010.
14. Centers for Disease Control and Prevention, National Center for Health Statistics. *Growth Charts*. Available at www.cdc.gov/growthcharts/index.htm, accessed June 1, 2022.
15. Leonberg, B. L. *Academy of Nutrition and Dietetics Pocket Guide to Pediatric Nutrition Assessment*, 3rd ed. Chicago, IL: American Academy of Nutrition and Dietetics, 2020.
16. D'Amico, A., et al. Spinal muscular atrophy. *Orphanet J Rare Dis*. 2011; 6:71.
17. Lucas, A., et al. Fetal origins of adult disease—The hypothesis revisited. *Br Med J*. 1999; 319(7204):245–249.
18. Dewey, K. G., & Begum, K. Long-term consequences of stunting in early life. *Matern Child Nutr*. 2011; 7(Suppl s3):5–18.
19. Duijts, L. Fetal and infant origins of a sthma. *Eur J Epidemiol*. 2012; 27(1):5–14.
20. Frisancho, A. R. Triceps skinfold and upper arm muscle size norms for assessment of nutritional status. *Am J Clin Nutr*. 1974; 27:1052–1157.
21. Fomon, S., et al. Body composition of reference children from birth to age 10 years. *Am J Clin Nutr*. 1982; 35:1169–1175.
22. Carel, J. C., et al. Long-term mortality after recombinant growth hormone treatment for isolated growth hormone deficiency or childhood short stature: Preliminary report of the French SAGhE study. *J Clin Endocrinol Metab*. 2012; 97(2):416–425.
23. Nellhaus, G. Composite international and interracial graphs. *Pediatr*. 1968; 41:106–114.
24. Batshaw, M. L. Chromosomes and heredity. In Batshaw, M. L., et al. (Eds.), *Children with disabilities*, 6th ed. Baltimore, MD: Paul H. Brookes, 2007:3–26, 770.

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Editorial review has deemed that any suppressed content does not materially affect the overall learning experience. Cengage Learning reserves the right to remove additional content at any time if subsequent rights restrictions require it.

References

25. *Growth references: Third Trimester to Adulthood*, 3rd ed. Clinton, SC: Greenwood Genetic Center, 2011.
26. Zemel, B. S., et al. Growth charts for children with Down Syndrome in the United States. *Pediatr.* 2015; 136:e1204–e1211.
27. Elias, E. R., Murphy N. A., & the Council on Children with Disabilities. Home care of children and youth with complex health care needs and technology dependencies. *Pediatr.* 2012; 129:996–1005.
28. Mahant, S., et al. Decision-making around gastrostomy—Feeding in children with neurologic disabilities. *Pediatr.* 2011; 127(6):e1471–e1481.
29. Mahant, S., et al. Well-being of children with neurologic impairment after fundoplication and gastrojejunostomy tube feeding. *Pediatr.* 2011; 128(2):e395–e403.
30. World Health Organization. Nutrition for HIV-infected infants and children. In *Antiretroviral therapy for HIV infections in infants and children: Towards universal access recommendations for a public health approach*. (pp. 69–75). Geneva: World Health Organization, 2010.
31. Shingadia, D., et al. Gastrostomy tube insertion for improvement of adherence to highly active antiretrovial therapy in pediatric patients with human immunodeficiency virus. *Pediatr.* 2000; 105:1–5.
32. Goday, P. S., Huh, S. Y., Silverman, A., Lukens, C. T., Dodrill, P., Cohen, S. S., Delaney, A. L., Feuling, M. B., Noel, R. J., Gisel, E., Kenzer, A., Kessler, D. B., Kraus de Camargo, O., Browne, J., & Phalen, J. A. Pediatric feeding disorder. *J Pediatr Gast roenterol Nutr.* 2019; 68(1):124–129. doi: 10.1097/MPG.0000000000002188.
33. Kovacic, K., Rein, L. E., Szabo, A., Kommareddy, S., Bhagavatula, P., & Goday, P. S. Pediatric feeding disorder: A nationwide prevalence study. *J Pediatr.* 2021; 228:126–131.e3. doi: 10.1016/j.jpeds.2020.07.047. Epub 2020 Jul 20. PMID: 32702429.
34. Stallings, V. A., et al., and Clinical Practice Guidelines on Growth and Nutrition Subcommittee; Ad Hoc Working Group. Evidence-based practice recommendations for nutrition-related management of children and adults with cystic fibrosis and pancreatic insufficiency: Results of a systematic review. *J Am Diet Assoc*. 2008; 108(5):832–839.
35. Yen, E. H., Quinton, H., Borowitz, D. Better nutritional status in early childhood is associated with improved clinical outcomes and survival in patients with cystic fibrosis. *J Pediatr.* 2013; 162(3):530–535 e531.
36. Chiang, J. L., Kirkman, M. S., Laffel, L. M., Peters, A. L., Type 1 Diabetes Sourcebook A. Type 1 diabetes through the lifespan: A position statement of the American Diabetes Association. *Diabetes Care*. 2014;37(7):2034–2054.
37. Crowther, N. J., et al. Influence of catch up growth on glucose tolerance and b-cell function in 7-year old children: Results from the birth to twenty study. *Pediatr.* 2008; 121:e1715–e1722.
38. Centers for Disease Control and Prevention. *National Diabetes Statistics Report— 2017*. Atlanta, GA. Centers for Disease Control and Prevention, U.S. Department of Health and Human Services, 2017. Available at www.cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf, accessed March 15, 2018.
39. Kossoff, E. H., et al. Ketogenic diets: An update for child neurologists. *J Child Neurol*. 2009; 24(8):979–988.
40. Pellegrino, L. Cerebral palsy. In: Batshaw, M. L., et al., eds. *Children with disabilities*, 6th ed. Baltimore, MD: Paul H. Brookes, 2007:387–408.
41. Burlina, A., and Blau, N. Effect of BH(4) supplementation on phenylalanine tolerance. *J Inherit Metab Dis*. 2009; 32(1):40–45.
42. Danielson, M. L., Bitsko, R. H., Ghandour, R. M., Holbrook, J. R., Kogan, M. D., & Blumberg, S. J. Prevalence of parent-reported ADHD diagnosis and associated treatment among U.S. children and adolescents, 2016. *J Clin Child Adolesc Psychol.* 2018 Mar–Apr; 47(2):199–212. doi: 10.1080/15374416.2017.1417860. Epub 2018 Jan 24. PMID: 29363986; PMCID: PMC5834391.
43. Zachor, D. A., et al. Effects of long-term psychostimulant medication on growth of children with ADHD. *Res Dev Disabil.* 2006; 27:162–174.
44. Catalá-López, F., Hutton, B., Núñez-Beltrán, A., Page, M. J., Ridao, M., Macías Saint-Gerons, D., Catalá, M. A., Tabarés-Seisdedos, R., & Moher, D. The pharmacological and non-pharmacological treatment of attention deficit hyperactivity disorder in children and adolescents: A systematic review with network meta-analyses of randomised trials. PLoS One. 2017 Jul 12; 12(7):e0180355. doi: 10.1371/journal.pone.0180355. PMID: 28700715; PMCID: PMC5507500.
45. Gupta, R. S., Springston, E. E., Warrier, M. R., Smith, B., Kumar, R., Pongracic, J., & Holl, J. L. The prevalence, severity, and distribution of childhood food allergy in the United States. *Pediatr.* 2011 Jul;128(1):e9–e17. doi: 10.1542/peds.2011–0204. Epub 2011 Jun 20. PMID: 21690110.
46. Yu, J. W., et al. Accidental ingestions in children with peanut allergy. *J Allergy Clin Immunol*. 2006; 118:466–472.
47. Bollinger, M. E., et al. The impact of food allergy on the daily activities of children and their families. *Ann Allergy Asthma Immunol*. 2006; 96:415–421.
48. Oriel, R. C., and Wang, J. How to manage food allergy in nursery or school. *Curr Opin Allergy Clin Immunol*. 2018; 18:258–264.
49. Centers for Disease Control and Prevention. *Voluntary Guidelines for Managing Food Allergies in Schools and Early Care and Education Programs*. Washington, DC: U.S. Department of Health and Human Services, 2013.
50. Wang, J., Sicherer, S. H.; AAP Section on Allergy and Immunology. Guidance on completing a written allergy and anaphylaxis emergency plan. *Pediatr.* 2017; 139:e20164005.
51. Kemper, K. J., et al.; Task Force on Complementary and Alternative Medicine. The use of complementary and alternative medicine in pediatrics. *Pediatr.* 2008; 122:1374–1386.
52. Ball, S. D., et al. Dietary supplement use is prevalent among children with a chronic illness. *J Am Diet Assoc*. 2005; 105(1):78–84.
53. National Down Syndrome Society. Alternative therapies. Available at https://www.ndss.org/resources/alternative-therapies/, accessed August 17, 2018.
54. Explore the Title V Federal-State Partnership. Maternal and Child Health Bureau, Health and Human Services. Available at https://mchb.tvisdata.hrsa.gov/, accessed August 17, 2018.

Chapter 14

1. Tanner, J. *Growth at Adolescence*. Oxford: Blackwell Scientific Publications, 1962.
2. Cabrera, S. M., Bright, G. M., Frane, J. W., Blethen, S. L., & Lee, P. A. Age of thelarche and menarche in contemporary US females: A cross-sectional analysis. *J Pediatr Endocrin Metab*. 2014; 27:47–51.
3. Barnes, H. V. Physical growth and development during puberty. *Med Clin North Am*. 1975; 59:1305–1317.
4. Poulton, A. S., et al. Growth and pubertal development of adolescent boys on stimulant medication for attention deficit hyperactivity disorder. *Med J Aust*. 2013; 198(1):29.
5. Frisch, R. E. Fatness, puberty, and fertility: The effects of nutrition and physical training on menarche and ovulation. In Brooks-Gunn, J., & Peterson, A. C. (Eds.). *Girls at Puberty: Biological and Psychosocial Perspectives*. New York: Plenum Press, 1983, 29–49.
6. Frisch, R. E., & McArthur, J. W. Menstrual cycles: Fatness as a determinant of minimum weight for height necessary for their maintenance or onset. *Science*. 1974; 185:949–951.
7. Golden, N. H., & Abrams, S. A. Committee on Nutrition. Optimizing bone health in children and adolescents. *Pediatrics*. 2014; 134(4):e1229–e1243. doi: 10.1542/peds.2014–2173.
8. National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Division of Behavioral and Social Sciences and Education; Board on Children, Youth, and Families; Committee on the Neurobiological and Socio-behavioral Science of Adolescent Development and Its Applications; Backes, E. P. & Bonnie, R. J. (Eds.). The Promise of Adolescence: Realizing Opportunity for All Youth. Washington, DC: National Academies Press (US);

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References

2019 May 16. 2, Adolescent Development. Available at https://www.ncbi.nlm.nih.gov/books/NBK545476/.

9. Steinberg, L. *Adolescence*, 9th ed. New York: McGraw Hill Higher Education, 2010.
10. Klump, K. L. Developmental trajectories of disordered eating: Genetic and biological risk during puberty. In Lewis, M., & Rudolph, K. D. (Eds.). *Handbook of developmental psychopathology*. Springer Science + Business Media, 2014:621–629. https://doi.org/10.1007/978-1-4614-9608-3_31.
11. Voelker, D. K., Reel, J. J., & Greenleaf, C. Weight status and body image perceptions in adolescents: current perspectives. *Adolesc Health Med Ther*. 2015; 6:149–158. doi: 10.2147/AHMT.S68344. eCollection 2015.
12. Pearson, N., Griffiths, P., Biddle, S. J. H., Johnston, J. P., & Haycraft, E. Individual, behavioural and home environmental factors associated with eating behaviours in young adolescents. *Appetite*. 2017; 112:35–43.
13. Ziedgler, A. M., Kasprzak, C. M., Mansouri, T. H., Gregory, A. M., et al. An ecological perspective of food choice and eating autonomy among adolescents. *Front Psychol*. 2021; 21. doi: https://doi.org/10.3389/fpsyg.2021.654139
14. Healthy Eating Index 2015 Scores for Americans. USDA, FNS Center for Nutrition Policy and Promotion. Available at https://www.fns.usda.gov/hei-scores-americans, accessed March 12, 2022.
15. Larson, N. I., Miller, J. M., Watts, A. W., Story, M., & Neumark-Sztainer, D. R. Adolescent snacking behaviors are associated with dietary intake and weight status. *J Nutrition*. 2016; 146:1348–1355.
16. Larson, N., et al. Multi-contextual correlates of energy-dense, nutrient-poor snack food consumption by adolescents. *Appetite*. 2017; 112:23–34.
17. U.S. Department of Agriculture, Agricultural Research Service. 2017–2018. Snacks: Percentages of selected nutrient contributed by food and beverages consumed at snack occasions, by gender and age, What We Eat in America, NHANES 2017–2018. Available at https://www.ars.usda.gov/ARSUserFiles/80400530/pdf/1718/Table_25_SNK_GEN_17.pdf, accessed March 12, 2022.
18. Reedy, J., & Krebs-Smith, S. M. Dietary sources of energy, solid fats, and added sugars among children and adolescents in the United States. *J Am Diet Assoc*. 2010; 110(10):1477–1484.
19. Marriott, B. P., Hunt, K. J., Malek, A. M., & Newman, J. C. Trend in intake of energy and total sugar from sugar-sweetened beverages in the Unites State among children and adults, NHANES 2003–2016. *Nutrients*. 2019; 11:2004. doi: https://dx.doi.org/10.3390%2Fnu11092004.
20. Merlo, C. L., Jones, S. E., Michael, S. L., et al. Youth risk behavior surveillance—United States, 2019. *MMWR*. 2019; 69(SS-01).
21. Terry, A. L., Wambogo, E., Ansai, N., & Ahluwalia, N. Breakfast intake among children and adolescents: United States, 2015–2018. NCHS Data Brief, no 386. Hyattsville, MD: National Center for Health Statistics, 2020.
22. Au, L. E., Gurzo, K., Gosliner, W., et al. Eating school meals daily is associated with healthier dietary intakes: The Healthy Communities Study. *J Acad Nutr Diet*. 2018; 118(8):1474–1481.e1.
23. Mathias, K. C., Jacquier, E., & Eldridge, A. L. Missing lunch is associated with lower intakes of micronutrients from foods and beverages among children and adolescents in the United States. *J Acad Nutr Diet*. 2016; 116:667–676.
24. U.S. Department of Agriculture, Agricultural Research Service. 2017. Away from home: Percentages of selected nutrients contributed by food and beverages, by gender and age. What We Eat in America, NHANES 2013–2014.
25. Poti, J. M., et al. Where are kids getting their empty calories? Stores, school and fast-food restaurants each played an important role in empty calorie intake among US children during 2009–2010. *JAND*. 2014; 114:908–917.
26. Potamites, E., & Gordon, A. Mathematica Policy Research, Inc. Children's Food Security and Intakes from School Meals. Final Report. May 2010. Available at https://www.ers.usda.gov/webdocs/publications/84357/ccr-61.pdf?v=9653.4, accessed March 16, 2022.
27. Gearan, E. C., Monzella, K., Jennings, L., & Fox, M. K. Differences in diet quality between school lunch participants and nonparticipant in the Unites States by income and race. *Nutrients*. 2020; 12:3891. doi: https://doi.org/10.3390/nu12123891.
28. McCullough, M. G., Robson, S. M., & Stark, L. J. A review of the structural characteristics of family meals with children in the United States. *Adv in Nutr*. 2016; 7:627–640.
29. Fulkerson, J. A., et al. A review of associations between family or shared meal frequency and dietary and weight status outcomes across the lifespan. *J Nutr Educ Behav*. 2014; 46:2.
30. Stahler, C., Mangels, R., for the Vegetarian Resource Group. How many youth in the US are vegan? Results of a 2021 YouGov Poll. Available at https://www.vrg.org/nutshell/Yougov2021youthteenwriteup.pdf, accessed March 20, 2022.
31. Shurmann, S., Kersting, M., & Alexy, U. Vegetarian diets in children: A systematic review. *Eur J Nutr*, 2017; 56:1797–1817.
32. Sutter, D. O., & Bender, N. Nutrient status and growth in vegan children. *Nutr Research*. 2021; 91:13–25.
33. Segovia-Siapco, G., Burkholder-Cooley, N., Tabrizi, S. H., & Sabate, J. Beyond meat: A comparison of the dietary intakes of vegetarian and non-vegetarian adolescents. *Front Nutr*. 2019; 13. https://doi.org/10.3389/fnut.2019.00086.
34. U.S. Department of Health and Human Services. *Physical activity guidelines for Americans*, 2nd ed. Washington, DC: US Department of Health and Human Services, 2018. Available at https://health.gov/sites/default/files/2019-09/Physical_Activity_Guidelines_2nd_edition.pdf.
35. American College of Sport Medicine. Physical activity in children and adolescents. Available at https://www.acsm.org/docs/default-source/files-for-resource-library/physical-activity-in-children-and-adolescents.pdf?sfvrsn=be7978a7_2, accessed March 20, 2022.
36. Food and Nutrition Board, Institute of Medicine; Otten, J. J., Hellwig, J. P., & Meyers, L. D. (Eds.). *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements*. Washington, DC: National Academies Press, 2006.
37. Dietary Guidelines Advisory Committee. 2020. *Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture and the Secretary of Health and Human Services*. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC.
38. What We Eat in America, NHANES 2017–2018, individuals 2 years and over (excluding breast-fed children), day 1. Available at www.ars.usda.gov/nea/bhnrc/fsrg, accessed March 20, 2022.
39. Bailey, D. A., Martin, A. D., McKay, H. A., Whiting, S., & Mirwald, R. Calcium accretion in girls and boys during puberty: A longitudinal analysis. *J Bone Miner Res*. 2000; 15(11):2245–2250.
40. Golden, N. H., Abrams, S. A., Committee on Nutrition, et al. Optimizing bone health in children and adolescents. *Pediatrics*. 2014; 134:e1229–e1243.
41. Centers for Disease Control and Prevention. Recommendations to prevent and control iron deficiency anemia in the United States. *Morb Mortal Wkly Rep*. 2002; 51(40):897–899.
42. Eicher-Miller, H. A., Mason, A. C., Weaver, C. M., McCabe, G. P., & Boushey, C. J. Food insecurity is associated with iron deficiency anemia in US adolescents. *Am J Clin Nutr*. 2009; 90(5):1358–1371.
43. Ginde, A. A., et al. Demographic differences and trends of vitamin D insufficiency in the U.S. population, 1988–2004. *Arch Intern Med*. 2009; 169(6):626–632.
44. Saggese, G., et al. Vitamin D in childhood and adolescence: An expert position statement. *Eur J Pediatr*. 2015; 174(5):565–576.
45. Smith, T. J., Tripkovic, L., Lanham-New, S. A., & Hart, K. H. Vitamin D in adolescence: Evidence-based dietary requirements and implications for public health policy. 2018; 77:292–301. doi:10.1017/S0029665117004104.
46. Institute of Medicine. *Dietary Reference Intakes for Calcium and Vitamin D*. Washington, DC: National Academies Press, 2011.
47. Herrick, K. A., Storandt, R. J., Afful, J., et al. Vitamin D status in the United States, 2011–2014. 2019; 110:150–157.

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References

48. Society for Adolescent Health and Medicine. Recommended vitamin D intake and management of low vitamin D status in adolescents: A position statement of the Society for Adolescent Health and Medicine. *J Adol Health*. 2013; 52:801–803.
49. Barlow, S. E. Expert committee recommendation regarding the prevention, assessment and treatment of child and adolescent overweight and obesity: Summary report. *Pediatrics*. 2007; 120:S164–S192.
50. National Cancer Institute. Automated Self-Administered 24-hour Dietary Recall. Available at https://epi.grants.cancer.gov/asa24/.
51. Robinson-O'Brien, R., et al. Adolescent and young adult vegetarianism: Better dietary intake and weight outcomes but increased risk of disordered eating behaviors. *J Am Diet Assoc*. 2009; 109(4):648–655.
52. Chassiakos, Y. R., et al. Children and adolescents and digital media. *Pediatrics*. 2016; 138(5). Available at http://pediatrics.aappublications.org.ezp3.lib.umn.edu/content/138/5.
53. Leverton, R. M. The paradox of teenage nutrition. *J Amer Diet Assoc*. 1968; 53:13–16.
54. Cutler, G. J., et al. Multiple sociodemographic and socio-environmental characteristics are correlated with major patterns of dietary intake in adolescents. *J Am Dietetic Assoc*. 2011; 111:230–240.
55. Health and social determinants and outcomes of home cooking: A systematic review of observational studies. *Appetite*. 2017; 111:116–134.
56. Watts, A., et al. The transmission of family food and mealtime practices from adolescence to adulthood: Longitudinal findings from Project EAT-IV. *J Nutr Ed Behav*. 2018; 50:141–147.
57. Centers for Disease Control and Prevention. Whole School Whole Community, Whole Child. Available at https://www.cdc.gov/healthyschools/wscc/index.htm, accessed March 21, 2022.
58. Centers for Disease Control and Prevention. School Health Index. 2017 Middle/High School. Available at https://www.cdc.gov/healthyschools/shi/pdf/Middle-High-Total-2017.pdf.
59. Centers for Disease Control and Prevention. School Health Policies and Practices Study: The Obesity Epidemic. Available at https://www.cdc.gov/healthyyouth/data/shpps/pdf/2014factsheets/2014_US_Obesity-Compliant.pdf.
60. Centers for Disease Control and Prevention. School Health Policies and Practices Study, 2016. Available at https://www.cdc.gov/healthyyouth/data/shpps/pdf/2016factsheets/Overview-SHPPS2016.pdf.
61. Tylka, T. L., Annunziato, R. A., Burgard, D., et al. The weight-inclusive versus weight-normative approach to health: Evaluating the evidence for prioritizing well-being over weight loss. *J Obes*. 2014. doi: https://doi.org/10.1155/2014/983495.
62. *Federal Register*. Volume 81, No. 146, 7 CFR Parts 210 and 220. Nutrition Standards in the National School Lunch and School Breakfast Programs; Final Rule. July 20, 2016.
63. United States Department of Agriculture, Food and Nutrition Service. Transitional standards for milk, whole grains and sodium—final rule. Available at https://www.fns.usda.gov/cn/fr-020722, accessed March 25, 2022.
64. Hayes, C., FitzSimons, C. for the Food Research & Action Center. The reach of breakfast and lunch: A look at pandemic and pre-pandemic participation. Feb. 2022. Available at https://frac.org/wp-content/uploads/SchoolMealsReport2022.pdf.
65. Local school wellness policy implementation under the Healthy, Hunger-free Kids Act of 2010. Available at https://www.federalregister.gov/documents/2016/07/29/2016-17230/local-school-wellness-policy-implementation-under-the-healthy-hunger-free-kids-act-of-2010.
66. Quinn, E. L., Johnson, D. B., Podrabsky, M., Saelens, B. E., Bignell, W., & Krieger, J. Effects of a behavioral economics intervention on food choice and food consumption in middle-school and high-school cafeterias. *Prev Chronic Dis*. 2018; 15:170377. doi: http://dx.doi.org/10.5888/pcd15.170377.
67. Metcalfe, J. J., Ellison, B., Hamdi, N., et al. A systematic review of school meal nudge interventions to improve youth food behaviors. *Int J Behav Nutr Phys Act*. 2020; 17, 77. https://doi.org/10.1186/s12966-020-00983-y.
68. Urban Roots, Annual Report 2019. Available at http://urbanrootsmn.org/about-us/.
69. Roots for the Home Team: Our Impact. Available at https://rootsforthehometeam.org/our-impact/.

Chapter 15

1. Barlow, S. E. Expert committee recommendation regarding the prevention, assessment and treatment of child and adolescent overweight and obesity: Summary report. *Pediatrics*. 2007; 120:S164–S192.
2. Styne, D. M., Arslanian, S. A., Connor, E. L., et al. Pediatric obesity—assessment, treatment and prevention: Endocrine Society Clinical Practice Guideline. *J Clinical Endo & Metab*. 2017; 102:709–757. doi: doi.org/10.1210/jc.2016-2573.
3. Kirk, S., Ogata, B., Wichert, E., et al. Treatment of pediatric overweight and obesity: Position of the Academy of Nutrition and Dietetics based on an umbrella review of systematic reviews. *J Acad Nutr Dietetics*. 2022; 122:848–861.
4. Fryar ,C. D., Carroll, M. D., & Afful, J. Prevalence of overweight, obesity, and severe obesity among children and adolescents aged 2–19 years: United States, 1963–1965 through 2017–2018. NCHS Health E-Stats. 2020.
5. Sanyaolu, A., Okorie, C., & Xiaohua, Q., et al. Childhood and adolescent obesity in the United States: A Public health concern. *Global Pediatr Health*. 2019; 6:1–11. doi: 10.1177/2333794X19891305.
6. Kelly, A. S., et al. Severe obesity in children and adolescents: Identification, associated health risks, and treatment approaches: A scientific statement from the American Heart Association. *Circulation*. 2013; 128:1689.
7. Reilly, J. J., & Kelly, J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: Systematic review. *Int J Obes*. 2011; 35:891.
8. Hampl, S. E., Hassink, S. G., Skinner, A. C., et al. Clinical Practice Guideline for the Evaluation and Treatment of Children and Adolescents With Obesity. *Pediatrics*. 2023; 151(2):e2022060640
9. Pratt, J. S. A., Browne, A., Browne, N. T., et al. ASMBS pediatric metabolic and bariatric surgery guidelines, 2018. *Surgery Obes Relat Diseases*. 2018; 14:882–901.
10. Priego, P. Special nutritional requirements in children and adolescents undergoing bariatric surgery. In Ruiz-Tovar, J. (Ed.), *Nutrition and Bariatric Surgery*. Elsevier, 2021: 187–198. ISBN: 978-0-12-822922-4.
11. Inge, T. H., et al. Weight loss and health status 3 years after bariatric surgery in adolescents. *N Engl J Med*. 2016; 374(2):113.
12. Golden, N. H., Schneider, M., Wood, C., AAP Committee on Nutrition. Preventing obesity and eating disorders in adolescents. *Pediatrics*. 2016; 138(3):e20161649.
13. Tylka, R. L., Annunziato, R. A., Danielsdottir, S., et al. The Weight-inclusive versus weight-normative approach to health: Evaluating the evidence for priotizing well-being over weight lost. *J Obesity*. 2014; Article ID 983495, 18 pages. https://doi.org/10.1155/2014/983495.
14. Haqq, A. M., Kebbe, M., Tan, Q., et al. Complexity and stigma of pediatric obesity. *Childhood Obesity*. 2021; 17: https://doi.org/10.1089/chi.2021.0003.
15. Centers for Disease Control and Prevention. Youth risk behavior surveillance—United States, 2015. *MMWR*. 2016; 65(6):15–42.
16. Golden, N. H., Schneider, M., Wood, C., Committee on Nutrition, Committee on Adolescence, Section on Obesity. Preventing obesity and eating disorders in adolescents. *Pediatrics*. 2016; 138:e20161649.
17. Abraham, S., et al. Time since menarche, weight gain and body image awareness among adolescent girls: Onset of eating disorders? *J Psychoso Obstet Gynaecol*. 2009; 30:89–94.
18. Ortega-Luyando, M., et al. Systematic review of disordered eating behaviours: Methodological considerations for epidemiological research. *Revista Mexicana de Trastornos Alimentarios*. 2015; 6(1):51–63.
19. Herpetz-Dahlmann, B. Adolescent eating disorders: Definitions, symptomatology, epidemiology and co-morbidity. *Child Adolesc Psychiatr Clin N Am*. 2009; 18(1):31–47.

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References

20. Agostino, H., Burstein, B., Moubayed, D., et al. Trends in the incidence of new-onset anorexia nervosa and Atypical anorexia nervosa among youth during the COVID-19 pandemic in Canada. *JAMA Netw Open*. 2021; 4(12):e2137395. doi: 10.1001/jamanetworkopen.2021.37395.
21. Campbell, K., & Peebles, R. Eating disorders in children and adolescents: State of the art review. *Pediatrics*. 2014; 134:582–592.
22. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders,* 5th ed. Arlington, VA, American Psychiatric Association, 2013. Available at www.dsm.psychiatryonline.org.
23. Steinhausen, H.-C. Outcome of eating disorders. *Child Adolesc Psychiatr Clin N Am*. 2008; 18:225–242.
24. Herpetz-Dahlmann, B., & Slaback-Andrae, H. Overview of treatment modalities in adolescent anorexia nervosa. *Child Adolesc Psychiatr Clin N Am*. 2008; 18:131–145.
25. Kjeldbjerg, M. L., & Clausen, L. Prevalence of binge-eating disorder among children and adolescents: A systematic review and meta-analysis. *Eur Child Adolesc Psychiatry*. 2021; doi: https://doi.org/10.1007/s00787-021-01850-2.
26. Haynos, A. F., et al. Factors predicting an escalation of restrictive eating during adolescence. *J Adolescent Health*. 2016; 59(4):391–396.
27. Shaw, H., Stice, E., & Becker, C. B. Preventing eating disorders. *Child Adolesc Psychiatr Clin N Am*. 2008; 18:199–207.
28. Merlo, C. L., Jones, S. E., Michael, S. L., et al. Dietary and physical activity behaviors among high school students—Youth Risk Behavior Survey, United States, 2019. *MMWR*. 2020; 69:64–76.
29. Position of the Academy of Nutrition and Dietetics, Dietitians of Canada and the American College of Sports Medicine: Nutrition and athletic performance. *J Acad Nutr Diet*. 2016; 116:501–528.
30. Hagan, J. F., et al. (Eds.). *Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents* [pocket guide], 4th ed. Elk Grove Village, IL: American Academy of Pediatrics, 2017.
31. U.S. Department of Health and Human Services, National Institutes of Health, National Heart, Lung and Blood Institute. Expert panel on integrated guidelines for cardiovascular health and risk reduction in children and adolescents. Summary report. NIH Publication No 12-7486A, October 2012.
32. Andes, L. J., Cheng, Y. J., Rolka, D. B., Gregg, E. W., & Imperatore, G. Prevalence of prediabetes among adolescents and young adults in the United States, 2005–2016. *JAMA Pediatr*. 2020; 174(2):e194498. doi:10.1001/jamapediatrics.2019.4498.
33. Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2020. Atlanta, GA: Centers for Disease Control and Prevention, U.S. Department of Health and Human Services; 2020.
34. Creamer, M. R., Jones, S. E., Gentzke, A. S., et al. Tobacco product use among high school students—Youth Risk Behavior Survey, United States, 2019. *MMWR*. 2020; 69:56–63.
35. Jones, C. M., Clayton, H. B., Deputy, N. P., et al. Prescription opioid misuses and use of alcohol and other substances among high school students—Youth Risk Behavior Survey, United States, 2019. *MMWR*. 2020; 69:38–46.
36. Pisetsky, E. M., et al. Disordered eating and substance use in high-school students: Results from the Youth Risk Behavior Surveillance System. *Int J Eat Disord*. 2008; 41(5):464–470.
37. Centers for Disease Control and Prevention. Recommendations to prevent and control iron-deficiency anemia in the United States. *Morb Mortal Wkly Rep*. 2002; 51(40):897–899.

Chapter 16

1. Ford, E. S., et al. Healthy living is the best revenge. Findings from the European Prospective Investigation into cancer and nutrition—Potsdam Study. *Arch Intern Med*. 2009; 169:1355–1362.
2. Fraser, G. E., et al. Ten years of life: Is it a matter of choice? *Arch Intern Med*. 2001; 161:1645–1652.
3. Flegal, K. M., Kit, B. K., Orpana, H., & Graubard, B. I. Association of all-cause mortality with overweight and obesity using standard body mass index categories: A systematic review and meta-analysis. *JAMA*. Jan 2, 2013; 309(1):71–82. PMID: 23280227.
4. See National Health and Nutrition Examination Survey at www.cdc.gov/nchs/nhanes/ and What We Eat in America at www.ers.usda.gov/.
5. BRFSS Prevalence and Trends Data. Available at cdc.gov/brfss/data_tools.htm.
6. World Health Organization: A conceptual framework for action on the social determinants of health: debates, policy & practice, case studies. Available at http://apps.who.int/iris/bitstream/10665/44489/1/9789241500852_eng.pdf, accessed January 17, 2022.
7. Sources for Social Determinants of Health. Available at cdc.gov/socialdeterminants/data/index.htm, accessed January 27, 2022.
8. Magnan, S. Social determinants of health 101 for health care: Five plus five. NAM Perspectives. Discussion Paper, National Academy of Medicine, Washington, DC, 2017. https://nam.edu/social-determinants-ofhealth-101-for-health-care-five-plus-five.
9. U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion. *Healthy People 2030*. Washington, DC, 2020. Available at http://healthypeople.gov/2030, accessed January 15, 2022.
10. Virani, S. S., et al. Heart disease and stroke statistics—2021 Update: A report from the American Heart Association. *Circulation*. 2021; 143(8):137. doi.org/10.1161/CIR.0000000000000950Circulation. 2021; 143:e254–e743.
11. Braveman, P. A. What are health disparities and health equity? We need to be clear. *Public Health Rep*. 2014; 129(Suppl 2):5–8.
12. McCartney, G., Popham, F., McMaster, R. & Cumbersc, C. Defining health and heath inequities. *Public Health*. 2019; 172:22–30. Published online May 30, 2019. doi: 10.1016/j.puhe.2019.03.023 PMCID: PMC6558275 PMID: 31154234. Accessed 1/17/2022.
13. *Promoting Health Equity: A Resource to Help Communities Address Social Determinants of Health*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2008.
14. Azzolino, D., Spolidoro, G. C. I., Saporiti, E., Luchetti, C., Agostoni, C., & Cesari, M. Musculoskeletal changes across the lifespan: Nutrition and the Life-Course Approach to Prevention. *Front Med* (Lausanne). 2021; 8:697954. doi: 10.3389/fmed.2021.697954. PMID: 34532328; PMCID: PMC8438318.
15. Favero, G., et al. Endothelium and it's alterations in cardiovascular disease: Life style interventions. *Biomed Res Int*. 2014; 801896. doi: 10.1155/2014/801896. Epub February 26, 2014.
16. Marlatt, K. L, et.al. Body composition and cardiometabolic health across the menopause transition. *Obesity*. 2021; 30(1): 14–27. doi.org/10.1002/oby.23289.
17. Gomes, S., Jacob, M., Rocha, C., Medeiros, M., Lyra, C., & Noro, L. Expanding the limits of sex: A systematic review concerning food and nutrition in transgender populations. *Public Health Nutrition*. 2021; 24(18):6436 –6449. doi: 10.1017/S1368980021001671.
18. Zhu, X., & Zheng, H. Factors influencing peak bone mass gain. *Front Med*. 2021; 15(1):53–69. doi: 10.1007/s11684-020-0748-y. Epub 2020 June 9. PMID: 32519297.
19. Kammerlander, A. A., Lyass, A., Mahoney, T. F., Massaro, J. M., Long, M. T., Vasan, R. S., & Hoffmann, U. Sex differences in the associations of visceral adipose tissue and cardiometabolic and cardiovascular disease risk: The Framingham Heart Study. *J Am Heart Assoc*. 2021; 10(11):e019968. doi: 10.1161/JAHA.120.019968. Epub 2021 May 15. PMID: 33998254; PMCID: PMC8483556.
20. Franceschi, C., Bonafè, M., Valensin, S., Olivieri, F., De Luca, M., Ottaviani, E., & De Benedictis, G. Inflamm-aging. An evolutionary perspective on immunosenescence. *Ann N Y Acad Sci*. 2000; 908:244–254. doi: 10.1111/j.1749-6632.2000.tb06651.x. PMID: 10911963.
21. Li, Y., Yun, K., & Mu, R. A review on the biology and properties of adipose tissue macrophages involved in adipose tissue physiological and pathophysiological processes. *Lipids Health Dis*. 2020; 19:164. https://doi.org/10.1186/s12944-020-01342-3.

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References

22. González, Olmo, B. M., Butler, M. J., & Barrientos, R. M. Evolution of the human diet and its impact on gut microbiota, immune responses, and brain health. *Nutrients*. 2021; 13(1):196. doi: 10.3390/nu13010196. PMID: 33435203; PMCID: PMC7826636.
23. Fassarella, M., Blaak, E. E., Penders, J., Nauta, A., Smidt, H., & Zoetendal, E. G. Gut microbiome stability and resilience: elucidating the response to perturbations in order to modulate gut health. *Gut*. 2021; 70(3):595–605. doi: 10.1136/gutjnl-2020-321747. Epub October 13, 2020. PMID: 33051190.
24. Arroyave, G. Genetic and biologic variability in human nutrient requirements. *Am J Clin Nutr*. 1979; 32:486–500.
25. Leyse-Wallace, R. *Linking Nutrition to Mental Health: A Scientific Exploration*. (Lincoln, NE: iUniverse, 2008).
26. Food and Nutrition Board, Institute of Medicine. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids*. (Washington, DC: National Academy Press, 2002/2005).
27. Human Energy Requirements. Report of a Joint FAO/WHO/UNU Expert Consultation. FAO Food and Nutrition Technical Report Series 1, Rome, 2004. Available at www.fao.org/docrep/007/y5686e/y5686e00.htm, accessed March 14, 2018.
28. Harper, E. J. Changing perspectives on aging and energy requirements: Aging and energy intakes in humans, dogs and cats. *J Nutr*. 1998; 128:2623S–2626S.
29. McGandy, R. B., et al. Nutrient intakes and energy expenditure of men of different ages. *J Gerontol*. 1966; 21:581–587.
30. Dietary Guidelines Advisory Committee. 2020. Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture and the Secretary of Health and Human Services. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC. Available at https://doi.org/10.52570/DGAC2020, accessed January 15, 2022.
31. Bendavid, I., Lobo, D. N., Barazzoni, R., et al. The centenary of the Harris–Benedict equations: How to assess energy requirements best? Recommendations from the ESPEN expert group. *J Clin Nutr*. 2021 Mar; 40(3):690-701. doi: 10.1016/j.clnu.2020.11.012. Epub 2020 Nov 20. PMID: 33279311.
32. Ravussin, E., et al. Twenty-four hour energy expenditure and resting metabolic rate in obese, moderately obese and control subjects. *Am J Clin Nutr*. 1982; 35:566–573.
33. Mifflin, M. C., et al. A new predictive equation for resting energy expenditure in healthy individuals. *Am J Clin Nutr*. 1990; 51:241–247.
34. Gerrior, S., et al. An easy approach to calculating estimated energy requirements. *Prev Chronic Dis*. 2006; 3(4):A129.
35. Hamwi, G. J. Therapy: Changing dietary concepts (Chapter 17). In Danowski, T. S. (Ed.), *Diabetes Mellitus: Diagnosis and Treatment*. New York: American Diabetes Association, 1964:73–78.
36. McClung, H. L., Raynor, H., et.al. A primer for the evaluation and integration of dietary and physical activity measurement tools into nutrition and dietetics practice. *J Acad Nutr Diet*. 2022; 122(1):207–217.
37. Dobbie, L. J., Tahrani, A., Alam, U., James, J., Wilding, J., & Cuthbertson, D. J. Exercise in obesity—The role of technology in health services: Can this approach work? *Curr Obes Rep*. 2021; 1–14. doi: 10.1007/s13679-021-00461-x. Epub ahead of print. PMID: 34791611; PMCID: PMC8597870.
38. Piaggi, P. Energy expenditure in the etiology of human obesity: Spendthrift and thrifty metabolic phenotypes and energy-sensing mechanisms. *J Endocrinol Invest*. 2018; 41(1):83–89. doi: 10.1007/s40618-017-0732-9. Epub July 24, 2017.
39. Kim, J. Y. Optimal diet strategies for weight loss and weight loss maintenance. *J Obes Metab Syndr*. 2021; 30(1):20–31. doi: 10.7570/jomes20065. PMID: 33107442; PMCID: PMC8017325.
40. McBurney, M. I., et al. Implications of US Nutrition Facts Label changes on micronutrient density of fortified foods and supplements. *J Nutr*. 2017; 147:1025–1030.
41. What We Eat in America, NHANES, 2017–2018. Nutrient Intakes from Food and Beverages. U.S. Department of Agriculture, Agriculture Research Service, 2017. Available at www.ars.usda.gov, accessed January 27, 2022.
42. Maldonado-Contreras, A. L., & McCormick, B. A. Intestinal epithelial cells and their role in innate mucosal immunity. *Cell Tissue Res*. 2011; 343(1):5–12.
43. Ross, C. A., et al. (Eds.). *Dietary Reference Intakes for Calcium and Vitamin D*. Institute of Medicine, 2010. Available at www.nap.edu.
44. Bailey, R. L., et al. Estimates of total and usual vitamin D intakes in the United States. *J Nutr*. 2010; 140:817–822.
45. de la Guía-Galipienso, F., Martínez-Ferran, M., Vallecillo, N., Lavie, C. J., Sanchis-Gomar, F., & Pareja-Galeano, H. Vitamin D and cardiovascular health. *Clin Nutr*. 2021; 40(5):2946–2957. doi: 10.1016/j.clnu.2020.12.025. Epub December 29, 2020. PMID: 33397599; PMCID: PMC7770490.
46. Abraham, A., Kattoor, A. J., Saldeen, T., & Mehta, J. L. Vitamin E and its anticancer effects. *Crit Rev Food Sci Nutr*. 2019; 59(17):2831–2838. doi: 10.1080/10408398.2018.1474169. Epub October 23, 2018. PMID: 29746786.
47. Wintergerst, E. S., et al. Contribution of selected vitamins and trace elements to immune function. *Ann Nutr Metab*. 2007; 51(4):301–323.
48. Bar-El Dadon, S., & Reifen, R. Vitamin A and the epigenome. *Crit Rev Food Sci Nutr*. 2017; 57(11):2404–2411. doi: 10.1080/10408398.2015.1060940. PMID: 26565606.
49. Ueland, P. M. Choline and betaine in health and disease. *J Inherit Metab Dis*. 2011; 34:3–15.
50. Anderson. O. S., et al. Nutrition and epigenetics: interplay of dietary methyl donors, one-carbon metabolism and DNA methylation. *J Nutr Biochem*. 2012; 23:853–859.
51. Mente, A., et al. Association of urinary sodium and potassium excretion with blood pressure. *N Engl J Med*. 2014; 371(7):601–611.
52. Ru, G., Nian, L., Rong, Y., Xiao-Yang, L., et al. Effects of the modified DASH Diet on adults with elevated blood pressure or hypertension: A systematic review and meta-analysis. *Frontiers in Nutr*. 2021; 8. https://www.frontiersin.org/article/10.3389/fnut.2021.725020. doi: 10.3389/fnut.2021.725020.
53. DiNicolantonio, J. J., et al. Subclinical magnesium deficiency: A principal driver of cardiovascular disease and a public health crisis. *Openheart*. 2018; 5:e000668. doi: 10.1136/openhrt-2017-000668.
54. Dibaba, D. T., et al. Dietary magnesium intake is inversely associated with serum C-reactive protein. *Eur J Clin Nutr*. 2014; 68(4):510–516.
55. González-Domínguez, Á., Visiedo-García, F. M., Domínguez-Riscart, J., González-Domínguez, R., Mateos, R. M., & Lechuga-Sancho, A. M. Iron metabolism in obesity and metabolic syndrome. *Inter J Mol Sci*. 2020; 21(15). ISSN: 1661–6596, 1422–0067; doi: 10.3390/ijms21155529; PMID: 32752277.
56. Seed, B. (2015). Sustainability in the Qatar national dietary guidelines, among the first to incorporate sustainability principles. *Public Health Nutr*. 18:132303–132310. doi: 10.1017/S1368980014002110.
57. Food Agriculture Organization of the United Nations (2019). Food-Based Dietary Guidelines. Available online at http://www.fao.org/nutrition/education/food-dietary-guidelines/home/en/, accessed January 27, 2022.
58. U.S. Department of Agriculture and U.S. Department of Health and Human Services. Dietary Guidelines for Americans, 2020–2025, 9th ed. December 2020. Available at DietaryGuidelines.gov.
59. USDA. MyPlate. Available at www.myplate.gov, accessed January 25, 2022.
60. Rock, C. L., et al. American Cancer Society guideline for diet and physical activity for cancer prevention. *CA Cancer J Clin*. 2020; 70(4):245–271. doi: 10.3322/caac.21591. Epub June 9, 2020. PMID: 32515498.
61. Lichtenstein, A. H., et al. 2021 dietary guidance to improve cardiovascular health: A scientific statement from the American Heart Association. *Circulation*. 2021; 144(23):e472–e487. https://doi.org/10.1161/CIR.0000000000001031.
62. Nitzke, S., & Freeland-Graves, J. Total diet approach to communicating food and nutrition information. *J Amer Diet Assoc*. 2007; 107(7):1224–1232.

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References

63. Britten P, et al. Impact of typical rather than nutrient-dense food choices in the US Department of Agriculture Food Patterns. *J Acad Nutr Diet*. 2012; 112:164–165.
64. Benton, D. Portion size: What we know and what we need to know. *Crit Rev Food Sci Nutr*. 2015; 55(7):988–1004.
65. Rolls, B. J. What is the role of portion control in weight management? *Int J Obes*. 2014; 38(Suppl 1):S1–S8. doi: 10.1038/ijo.2014.82.
66. Food and Nutrition Board, Institute of Medicine of the National Academy of Sciences. *Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate*. Washington, DC: The National Academy Press, 2005.
67. Kenefick, R. W. Drinking strategies: Planned drinking versus drinking to thirst. *Sports Med. (Auckland, NZ)*. 2018; 48(Suppl 1): 31–37. doi: 10.1007/s40279-017-0844-6.
68. Martin, C. L., John C. Clemens, J. C., & Moshfegh, A. J. Beverage choices among adults: What we eat in America, *NHANES*. 2017–2018. October 2020. Accessed January 12, 2022.
69. McCrickered, K., et al. Fluid or fuel? The context of consuming a beverage is important for satiety. *PLoS One*. 2014; 9(6):e100406. doi: 10.1371/journal.pone.0100406.
70. Rethink Your Drink. https://www.cdc.gov/healthyweight/healthy_eating/drinks.html, accessed January 7, 2022.
71. Cornelis, M. C. The impact of caffeine and coffee on human health. *Nutrients*. 2019; 11(2):416. doi: 10.3390/nu11020416. PMID: 30781466; PMCID: PMC6413001.
72. Dietary Guidelines Advisory Committee. 2020. Part D, Chapter 11 Alcoholic Beverages in *Scientific Report of the 2020 Dietary Guidelines Advisory Committee: Advisory Report to the Secretary of Agriculture and the Secretary of Health and Human Services*. U.S. Department of Agriculture, Agricultural Research Service, Washington, DC. Available at https://doi.org/10.52570/DGAC2020.
73. Blumberg, J. B., et al. Contribution of dietary supplements to nutritional adequacy by socioeconomic subgroups in adults of the United States. *Nutrients*. 2018; 10(1):4. doi: 10.3390/nu10010004.
74. Office of Dietary Supplements. Dietary Supplement Fact Sheets. Available at https://ods.od.nih.gov, accessed January 25, 2022.
75. Crowe, K. M., & Coni Francis, C. Position of the Academy of Nutrition and Dietetics: Functional foods. *J Academy Nutr Diet*. 2013; 113:1096–1103. doi: doi.org/10.1016/j.jand.2013.06.002.
76. Serafini, M., & Peluso, I. Functional foods for health: The interrelated antioxidant and anti-inflammatory role of fruits, vegetables, herbs, spices and cocoa in humans. *Curr Pharm Des*. 2016; 22(44):6701–6715.
77. Kunnumakkara, A. H., et al. Chronic diseases, inflammation, and spices: How are they linked? *J Transl Med*. 2018; 16:14. doi: 10.1186/s12967-018-1381-2.
78. Giada, M. L. R. Food phenolic compounds: Main classes, sources, and their antioxidant power (Chapter 4). In Morales-Gonzalez, J. A. (Ed.), *Oxidative Stress and Chronic Degenerative Diseases: A Role of Antioxidants*. London: Intechopen, 2013. doi: http://dx,doi.org/10.5773/51687.
79. Satter, E. Eating competence: Definition and evidence for the Satter Eating Competence Model. *J Nutr Educ Behav*. 2007; 39(Suppl):S142–S153.
80. Satter, E. Eating competence: Nutrition education with the Satter Eating Competence Model. *J Nutr Educ Behav*. 2007; 39(Suppl):S189–S194.
81. 2018 Physical Activity Guidelines Advisory Committee Scientific Report to the Secretary of Health and Human Services. Available at health.gov/, accessed January 27, 2022.
82. *Physical Activity Guidelines for Americans*, 2nd ed. Office of Disease Prevention and Health Promotion. Available at health.gov/, accessed January 27, 2022.
83. Progress and New Directions in Physical Activity Surveillance, Supplement to *Journal of Physical Activity and Health* 2021; 18(S1) in *Journal of Physical Activity and Health*. Print ISSN: 1543-3080, Online ISSN: 1543-5474. Accessed January 28, 2022.
84. WHO guidelines on physical activity and sedentary behaviour. Geneva World Health Organization, 2020. Available at https://www.who.int/publications/i/item/9789240015128, accessed June 6, 2023.
85. Stappers, N. E. H., Van Kann, D. H. H., Ettema, D., De Vries, N. K., & Kremers, S. P. J. The effect of infrastructural changes in the built environment on physical activity, active transportation and sedentary behavior—A systematic review. *Health Place. 2018;* 53:135–149. https://doi.org/10.1016/j.healthplace.2018.08.002.
86. Thomas, D. T., et al. Position paper of the American Dietetic Association and the Canadian Dietetic Association: Nutrition and athletic performance. *J Acad Nutr Diet*. 2016; 116:501–528.
87. Guest, N. S., VanDusseldorp, T. A., Nelson, M. T., Grgic, J., Schoenfeld, B. J., Jenkins, N. D. M., Arent, S. M., Antonio, J., Stout, J. R., Trexler, E. T., Smith-Ryan, A. E., Goldstein, E. R., Kalman, D. S., & Campbell, B. I. International society of sports nutrition position stand: Caffeine and exercise performance. *J Int Soc Sports Nutr*. 2021; 18(1):1. doi: 10.1186/s12970-020-00383-4. PMID: 33388079; PMCID: PMC7777221. Accessed January 25, 2022.
88. Buell, J. L., et al. National Athletic Trainers' Association Position Statement: Evaluation of dietary supplements for performance nutrition. *J Athl Train*. 2013; 48(1): 124–136. doi: 10.4085/1062-6050-48.1.16.
89. Bleich, S. N., et al. A systematic review of calorie labeling and modified calorie labeling interventions: Impact on consumer and restaurant behavior. *Obesity*. 2017; 25(12):2018–2044.
90. Itria, A., Borges, S. S., Rinaldi, A. E. M., Nucci, L. B., & Enes, C. C. Taxing sugar-sweetened beverages as a policy to reduce overweight and obesity in countries of different income classifications: A systematic review. *Public Health Nutr*. 2021; 24(16):5550–5560. doi: 10.1017/S1368980021002901. Epub July 5, 2021. PMID: 34218837.
91. *Sisters Together Program Guide*. Weight-control Information Network (WIN), National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). Available at http://win.niddk.nih.gov/publications/SisPrmGuide2.pdf, accessed March 12, 2018.
92. James, D. C., Harville, C., McQueen, D. S., & Facey, J. A. "I want a program that looks at my whole life." A focus group study on the ideal components for an mhealth weight management program for African American Women. *J Acad Nutr Diet*. 2022; 122(1);139–148.
93. Coleman-Jensen, A., et al. *Household Food Security in the United States in 2020*. USDA/Economic Research Service, Report Number (ERR-298), September 2021.
94. Shrider, E. A., Kollar, M., Chen, F., & Semeg, J. Income and Poverty in the United States: 2020. Report Number P60-273. US Census Bureau, September 14, 2021. Census.gov. Accessed January 27, 2022.
95. HHS Poverty Guidelines for 2023. Federal Register Notice, January 19, 2023. Accessed June 6, 2023.
96. USDA, Food and Nutrition Services. Programs and Services. Available at www.fns.usda.gov/prorms-and-services, accessed January 28, 2022.
97. Rivera, R. L., Maulding, M. K., & Eicher-Miller, H. A. Effect of Supplemental Nutrition Assistance Program-Education (SNAP-Ed) on food security and dietary outcomes. *Nutr Rev*. 2019; 77(12): 903–921. doi: 10.1093/nutrit/nuz013. PMID: 31077323.
98. Holben, D. H. Position of the Academy of Nutrition and Dietetics: Food security in the United States. *J Acad Nutr Diet*. 2017; 117:1991–2002.

Chapter 17

1. Heron, M. Deaths: Leading causes for 2019. *National Vital Statistics Reports*. 70(9). Hyattsville, MD: National Center for Health Statistics. 2021. doi: https://dx.doi.org/10.15620/cdc:107021. Accessed February 10, 2022.
2. Garvey, W. T., et al. American Association of Clinical Endocrinologists and American College of Endocrinology Comprehensive Clinical Practice Guidelines for medical care of patients with obesity. *Endocr Pract*. 2016; 22(Suppl 3):1–203. doi: 10.4158/EP161365.GL. Epub May 24, 2016.
3. Heymsfield, S. B., & Wadden, T. A. Mechanisms, pathophysiology, and management of obesity *NEJM*. 2017; 376(15):254–266.
4. Hales, C. M., Carroll, M. D. Fryar, C. D., & Ogden, C. L. *Prevalence of Obesity*

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References

and Severe Obesity Among Adults: United States, 2017–2018. NCHS Data Brief No. 360, February 2020

5. Centers for Disease Control and Prevention. *Adult Obesity Prevalence Maps*. Available at https://www.cdc.gov/obesity/data/prevalence-maps.html, accessed March 3, 2022.
6. Torres-Fuentes, C., et al. The microbiota-gut-brain axis in obesity. *Lancet Gastroenterol Hepatol*. October 2017; 2(10):747–756. doi: 10.1016/S2468-1253(17)30147-4. Epub August 24, 2017.
7. Yu, Y-H. et al. Metabolic vs. hedonic obesity: A conceptual distinction and its clinical implications. *Obesity Rev*.2015; 16:234–247.
8. Singh, R. K., Kumar, P., & Mahalingam, K. Molecular genetics of human obesity: A comprehensive review. *C R Biol*. 2017; 340(2):87–108. Doi: 10.1016/j.crvi.2016.11.007. PMID:28089486.
9. Mayoral, L. P., et al. Obesity subtypes, related biomarkers & heterogeneity. *Indian J Med R*. 2020; 151(1):11–21. Doi: 10.4103/ijmr.UMR_1768_17. PMID: 32134010.
10. Ramos-Lopez, O., Milton-Laskibar, I., & Martínez, J. A. Precision nutrition based on phenotypical traits and the (epi)genotype: Nutrigenetic and nutrigenomic approaches for obesity care. *Curr Opin Clin Nutr Metab Care*. 2021; 24(4):315–325. doi: 10.1097/MCO.0000000000000754. PMID: 33859118.
11. Clusky, M., & Grobe, D. College weight gain and behavior transitions: Male and female differences. *J Amer Diet Assoc*. 2009; 109:325–329.
12. Cooper, A. J., Gupta, S. R., Moustafa, A. F., & Chao, A. M. Sex/gender differences in obesity prevalence, comorbidities, and treatment. *Curr Obes Rep*. 2021; 10(4):458-466. doi: 10.1007/s13679-021-00453-x. Epub October 2, 2021. PMID: 34599745.
13. *Report of the 2020-25 Dietary Guidelines Advisory Committee*. Available at https://www.dietaryguidelines.gov/2020-advisory-committee-report, accessed February 15, 2022.
14. Egger, G., & Dixon, J. Beyond obesity and lifestyle: A review of 21st century chronic disease determinants. *BioMed Res Int*. 2014. doi: 10.1155/2017/731685.
15. Puhl, R. M., & Heuer, C. A. Obesity stigma: Important considerations for public health. *Am J Public Health*. 2010; 100:1019–1028.
16. Upadhyay, J., et al. Obesity as a disease. *Med Clin North Am*. 2018; 102(1):13–33. doi: 10.1016/j.mcna. 2017.08.004. Epub October 21, 2017.
17. Blüher, M. Metabolically healthy obesity. *Endocrine Review*. 2020; 41(3), bnaa004, https://doi.org/10.1210/endrev/bnaa004.
18. Magkos, F. Metabolically healthy obesity: What's in a name? *Amer J Clin Nutr*. 2019;110(3):533–539. https://doi.org/10.1093/ajcn/nqz133
19. World Health Organization, Organization for Economic Cooperation and Development. *Obesity Update: 2017*. Available at www.oecd.org/health/obesity-update.htm, accessed February 15, 2022.
20. Lohman, T., et al. *Anthropometric Standardization Reference Manual*. Champaign, IL: Human Kinetics, 1991.
21. Longo, D. L., et al. Mechanisms, pathophysiology, and management of obesity. *NEJM*. 2017; 376:254–266.
22. Swainson, M. G., Batterham, A. M., Tsakirides, C., Rutherford, Z. H., & Hind, K. Prediction of whole-body fat percentage and visceral adipose tissue mass from five anthropometric variables. *PLOS One*. 2017; 12(5):e0177175. doi: 10.1371/journal.pone.0177175. PMID: 28493988; PMCID: PMC5426673.
23. Fontana, L., et al. Optimal body weight for health and longevity: Bridging basic, clinical, and population research. *Aging Cell*. 2004; 13:391–400.
24. Meredith-Jones, K., Taylor, R., Brown, R., et.al. Age- and sex-specific visceral fat reference cutoffs and their association with cardio-metabolic risk. *Int J Obes (Lond)*. 2021; 45(4):808–817. doi: 10.1038/s41366-021-00743-3. Epub January 20, 2021. PMID: 33473174.
25. Ward, L. C. Bioelectrical impedance analysis for body composition assessment: Reflections on accuracy, clinical utility, and standardization. *Eur J Clin Nutr*. 2019; 73(2):194–199. doi: 10.1038/s41430-018-0335-3. PMID: 30297760.
26. Fortin, A. H., et al. (Eds.). Smith's *Patient-Centered Interviewing: An Evidenced-Based Method*, 3rd ed. New York: McGraw-Hill, 2012.
27. Wadden, T. A., Tronieri, J. S., & Butryn, M. L. Lifestyle modification approaches for the treatment of obesity in adults. *Am Psychol*. 2020; 75(2):235–251. doi: 10.1037/amp0000517. PMID: 32052997
28. Wharton, S., Lau, D. C. W., Vallis, M., et al. Obesity in adults: A clinical practice guideline. *CMAJ*. 2020; 192(31): E875-E891.
29. U.S. Preventive Services Task Force. *Weight Loss to Prevent Obesity-Related Morbidity and Mortality in Adults: Behavioral Interventions*. September 18, 2018. Available at www.uspreventiveservicestaskforce.org, accessed February 15, 2022.
30. LeBlanc, E. L., et al. *Behavioral and pharmacotherapy weight loss interventions to prevent obesity-related morbidity and mortality in adults: An updated systematic review for the U.S. Preventive Services Task Force*. *JAMA*. 2018; 320(11): 1172–1191. doi:10.1001/jama.2018.7777.
31. Jull, S. D. Middle-aged women's decisions about body weight management: Needs assessment and testing of a knowledge translation tool. *Menopause*. 2015; 22(4):414–422. doi: 10.1097/GME.0000000000000326.
32. Robertson, C., et al. Systematic reviews of and integrated report on the quantitative, qualitative and economic evidence base for the management of obesity in men. *Health Technol Assess*. May 2014; 18(35):v–vi, xxiii–xxix, 1–424. doi: 10.3310/hta18350.
33. Kushner, R., Bessesen, D. H., & Gilden, A. H. (Eds.). *Primary Care: Evaluation and Management of Obesity*. Phidelphia, PA: Wolters Kluwer. 2021.
34. McCarthy, D., & Berg, A. Weight loss strategies and the risk of skeletal muscle mass loss. *Nutrients*. 2021; 13:2473. https://doi.org/10.3390/nu13072473.
35. Santos, H. O., Genario, R., Tinsley, G. M., et. al. A scoping review of intermittent fasting, chronobiology, and metabolism. *Am J Clin Nutr*. 2022; nqab433. doi: 10.1093/ajcn/nqab433. Epub ahead of print. PMID: 34978321.
36. Regmi, P., & Heilbronn, L. K. Time-restricted eating: Benefits, mechanisms, and challenges in translation. *iScience*. 2020; 23(6):101161. doi: 10.1016/j.isci.2020.101161.
37. Castelnuovo, G., et al. Cognitive behavioral therapy to aid weight loss in obese patients: Current perspectives. *Psychol Res Behav Manag*. 2017; 10:165–173. Published online June 6, 2017. doi: 10.2147/PRBM.S113278.
38. *2018 Physical Activity Guidelines Advisory Committee Scientific Report to the Secretary of Health and Human Services*, 2017. U.S. Department of Health and Human Services website. Available at http://health.gov/paguidelines/second-edition/report/pdf/02, accessed March 14, 2018.
39. Jakicic, J. M., et al. Effect of exercise on 24-month weight loss maintenance in overweight women. *Arch Intern Med*. 2008; 168:1550–1559.
40. Brown, W. J., et al. Identifying the energy gap: magnitude and determinants of 5-year weight gain in midage women. *Obesity Res*. 2005; 13:1431–1441. First published September 6, 2012. https://doi.org/10.1038/oby.2005.173.
41. Müller, T. D., Blüher, M., Tschöp, M. H., et al. Anti-obesity drug discovery: Advances and challenges. *Nat Rev Drug Discov*. 2021. https://doi.org/10.1038/s41573-021-00337-8.
42. Office of Dietary Supplements. *Dietary Supplements for Weight Loss. Fact Sheet for Health Professionals*. Available at http://ods.od.nih.gov/factsheets/WeightLoss-HealthProfessional, accessed March 3, 2022.
43. Arterburn, D. E., Telem, D. A., Kushner, R. F., & Courcoulas, A. P. Benefits and risks of bariatric surgery in adults: A review. *JAMA*. 2020; 324(9):879–887. doi:10.1001/jama.2020.12567
44. Bundy, J. D., Ning, H., Zhong, V. W., et al. Cardiovascular health score and lifetime risk of cardiovascular disease: The cardiovascular lifetime risk pooling project. *Circ Cardiovasc Qual Outcomes*. 2020:CIRCOUTCOMES119006450. doi: 10.1161/CIRCOUTCOMES.119.006450. Epub ahead of print. PMID: 32600064; PMCID: PMC7772276.
45. Office of Disease Prevention and Health Promotion. *Heart Disease and Stroke. Healthy People 2030*. U.S. Department of

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References

Health and Human Services. Available at https://health.gov/healthypeople/objectives-and-data/browse-objectives/heart-disease-and-stroke, accessed February 22, 2022.

46. Tsao, C. W., Aday, A. W., Almarzooq, Z. I., et. al. American Heart Association Council on Epidemiology and Prevention Statistics Committee and Stroke Statistics Subcommittee. Heart Disease and Stroke Statistics—2022 Update: A Report From the American Heart Association. *Circulation*. 2022:CIR0000000000001052. doi: 10.1161/CIR.0000000000001052. Epub ahead of print. PMID: 35078371.
47. Centers for Disease Control and Prevention. *Heart Disease Facts and Stroke Facts*. Available at https://www.cdc.gov, accessed February 21, 2022.
48. Jilani M. H., Javed Z., Yahya T., et al. Social determinants of health and cardiovascular disease: Current state and future directions towards healthcare equity. *Curr Atheroscler Rep*. 2021; 23(9):55. doi: 10.1007/s11883-021-00949-w. PMID: 34308497.
49. Kris-Etherton, P. M., Petersen, K. S., Velarde, G., et al. Barriers, opportunities, and challenges in addressing disparities in diet-related cardiovascular disease in the United States. *J Am Heart Assoc*. 2020; 9:e014433. doi: 10.1161/JAHA.119.014433.
50. Lee, C. D., et al. Abdominal obesity and coronary artery calcification in young adults: The Coronary Artery Risk Development in Young Adults (CARDIA) Study. *Am J Clin Nutr*. 2007; 86:48–54.
51. Schloss, M. J., Swirski, F. K., & Nahrendorf, M. Modifiable cardiovascular risk, hematopoiesis, and innate immunity. *Circ Res*. 2020; 126(9):1242–1259. doi: 10.1161/CIRCRESAHA.120.315936. Epub 2020 Apr 23. PMID: 32324501; PMCID: PMC7185037.
52. Eckel, R. H., et al. AHA/ACC Guidelines on lifestyle management to reduce cardiovascular risk. *Circulation*. 2014; 129:S76–S99. Published online before print November 12, 2013, doi: 10.1161/01.cir.0000437740.48606.d1.
53. Goff, D. C., et al. ACC/AHA Guidelines on the assessment of cardiovascular risk. J *Am Coll Cardiol*. July 1, 2014; 63(25 Pt B):2935–2959. doi: 10.1016/j.jacc.2013.11.005.
54. Koba, S. K., et al. Small dense low-density lipoprotein cholesterol is a promising biomarker for secondary prevention in older men with stable coronary artery disease. *Geriatr Gerontol Int*. March 7, 2018. doi: 10.1111/ggi.13287. PMID: 29512264.
55. Price, M. A., Alvarado, B. E., Rosendaal, N. T. A., et al. Early and surgical menopause associated with higher Framingham Risk Scores for cardiovascular disease in the Canadian Longitudinal Study on Aging. *Menopause*. 2021; 28(5):484-490. doi: 10.1097/GME.0000000000001729. PMID: 33399323; PMCID: PMC8284368.
56. Lehker, A., Mukherjee, D. Coronary calcium risk score and cardiovascular risk. *Curr Vasc Pharmacol*. 2021; 19(3):280–284. doi: 10.2174/1570161118666200403143518. PMID: 32242784.
57. Reyes-Soffer, G., Ginsberg, H. N., Berglund, L., et al. American Heart Association Council on Arteriosclerosis, Thrombosis and Vascular Biology; Council on Cardiovascular Radiology and Intervention; and Council on Peripheral Vascular Disease. Lipoprotein(a): A Genetically Determined, Causal, and Prevalent Risk Factor for Atherosclerotic Cardiovascular Disease: A Scientific Statement From the American Heart Association. *Arterioscler Thromb Vasc Biol*. 2022; 42(1):e48–e60. doi: 10.1161/ATV.0000000000000147. Epub October 14, 2021. PMID: 3464748
58. Van der Laarse, A., & Cobbaert, C. M. Biochemical risk factors of atherosclerotic cardiovascular disease: from a narrow and controversial approach to an integral approach and precision medicine. *Expert Rev Cardiovasc Ther*. 2021; 19(12):1085–1096. doi: 10.1080/14779072.2021.2022475. Epub January 3, 2022. PMID: 34937476.
59. Sikand, G., & Severson, T. Top 10 dietary strategies for atherosclerotic cardiovascular risk reduction. *Am J Prev Cardiol*. 2020; 4:100106. doi: 10.1016/j.ajpc.2020.100106.
60. Grundy, S. M., Stone, N. J., Bailey, A. L., et al. AHA/ACC/AACVPR/AAPA/ABC/ACPM/ADA/AGS/APhA/ASPC/NLA/PCN A guideline on the management of blood cholesterol: A report of the American College of Cardiology/American Heart Association task force on clinical practice guidelines. *J Am Coll Cardiol*. 2018 doi: 10.1016/j.jacc.2018.11.003. Epub ahead of print November 8, 2018. pii: S0735-1097(18)39034-X.
61. Arnett, D. K., Blumenthal, R. S., Albert, M. A., et al. 2019 ACC/AHA Guideline on the Primary Prevention of Cardiovascular Disease: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Circulation*. 2019; 140(11):e563–e595. doi: 10.1161/CIR.0000000000000677. Epub March 17, 2019.
62. Patnode, C. D., et al. *Behavioral Counseling to Promote a Healthful Diet and Physical Activity for Cardiovascular Disease Prevention in Adults Without Known Cardiovascular Disease Risk Factors: Updated Systematic Review for the U.S. Preventive Services Task Force* [Internet]. Rockville (MD): Agency for Healthcare Research and Quality (US); July 2017. Report No.: 15-05222-EF-1. Available at https://jamanetwork.com/journals/jama/fullarticle/2643315, accessed February 15, 2022.
63. Mozaffarian, D., et al. Population approaches to improve diet, physical activity and smoking habits: A scientific statement of the American Heart Association. *Circulation*. 2012; 126:1514–1563.
64. Kris-Etherton, P. M., Petersen, K. S., Després, J. P., et al., and on behalf of the American Heart Association Council on Lifestyle and Cardiometabolic Health; Council on Cardiovascular and Stroke Nursing; Stroke Council; Council on Clinical Cardiology; Council on Arteriosclerosis, Thrombosis and Vascular Biology; and Council on Hypertension. Strategies for Promotion of a Healthy Lifestyle in Clinical Settings: Pillars of Ideal Cardiovascular Health: A Science Advisory From the American Heart Association. *Circulation*. 2021; 144(24); e495–e514. https://doi.org/10.1161/CIR.0000000000001018.
65. Van Horn, L., Carson, J. A. S., Appel, L. J., et al; on behalf of the American Heart Association Nutrition Committee of the Council on Lifestyle and Cardiometabolic Health; Council on Cardiovascular Disease in the Young; Council on Cardiovascular and Stroke Nursing; Council on Clinical Cardiology; and Stroke Council. Recommended dietary pattern to achieve adherence to the American Heart Association/American College of Cardiology (AHA/ACC) guidelines: A scientific statement from the American Heart Association. *Circulation*. 2016; 134:e505–e529. doi: 10.1161/CIR.0000000000000462.
66. U.S. Preventive Services Task Force, Krist, A. H., Davidson, K. W., Mangione, C. M., et al. Behavioral counseling interventions to promote a healthy diet and physical activity for cardiovascular disease prevention in adults with cardiovascular risk factors: U.S. Preventive Services Task Force Recommendation Statement. *JAMA*. 2020; 324(20):2069–2075. doi: 10.1001/jama.2020.21749. PMID: 33231670.
67. Gylling, H., Strandberg, T. E., Kovanen, P. T., & Simonen, P. Lowering low-density lipoprotein cholesterol concentration with plant stanol esters to reduce the risk of atherosclerotic cardiovascular disease events at a population level: A critical discussion. *Nutrients*. 2020; 12(8):2346. doi: 10.3390/nu12082346. PMID: 32781511; PMCID: PMC7468994.
68. Gunness, P., & Gidley, M. J. Mechanisms underlying the cholesterol lowering properties of soluble dietary fibre polysaccharides. *Food Funct*. 2010; 1:149–155. doi: https://doi.org/10.1039/c0fo00080a.
69. Dahl, W. J., & Stewart, M. L. Position of the Academy of Nutrition and Dietetics: Health implications of dietary fiber. *J Am Diet Assoc*. 2015; 115:1861–1870.
70. Almeida, S. O., & Budoff, M. Effect of statins on atherosclerotic plaque. *Trends Cardiovasc Med*. 2019; 29(8):451–455. doi: 10.1016/j.tcm.2019.01.001. Epub January 7, 2019. PMID: 30642643.
71. Alberti, K. G. M. M., et al. Harmonizing the metabolic syndrome: A joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. *Circulation*. 2009; 120:1645–1650.

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References

72. Moore, J. X., et al. Metabolic syndrome prevalence by race/ethnicity and sex in the United States, National Health and Nutrition Examination Survey, 1988–2012. *Prev Chronic Dis*. 2017; 14:160287. doi: http://dx.doi.org/10.5888/pcd14.160287.
73. Shi, T. H., Wang, B., & Natarajan, S. The influence of metabolic syndrome in predicting mortality risk among U.S. adults: Importance of metabolic syndrome even in adults with normal weight. *Prev Chronic Dis* 2020; 17:200020. doi: http://dx.doi.org/10.5888/pcd17.200020.
74. Godfrey, T. M., Cordova-Marks, F. M., Jones, D., Melton, F., & Breathett, K. Metabolic syndrome among American Indian and Alaska native populations: Implications for cardiovascular health. *Curr Hypertens Rep*. 2022. doi: 10.1007/s11906-022-01178-5. Epub ahead of print. PMID: 35181832.
75. Sumner, A., & Cowie, C. C. Ethnic differences in the ability of triglyceride levels to identify insulin resistance. *Atherosclerosis*. 2008; 196:696–703.
76. Fahed, G., Aoun, L., Bou Zerdan, M., Allam, S., Bou Zerdan, M., Bouferraa, Y., & Assi, H. I. Metabolic syndrome: Updates on pathophysiology and management in 2021. *Int J Mol Sci*. 2022; 23(2):786. doi: 10.3390/ijms23020786. PMID: 35054972; PMCID: PMC8775991.
77. Van Namen, M., Prendergast, L., & Peiris, C. Supervised lifestyle intervention for people with metabolic syndrome improves outcomes and reduces individual risk factors of metabolic syndrome: A systematic review and meta-analysis. *Metabolism*. 2019; 101:153988. doi: 10.1016/j.metabol.2019.153988. Epub October 28, 2019. PMID: 31672441.
78. Higgins, S. P., et al. *Acanthosis nigricans*: A practical approach to evaluation and management. *Dermatology Online J*. 2008; 19(9):2.
79. Misra, A., et al. Novel phenotype markers and screening score for the metabolic syndrome in adult Asian Indians. *Diabetes Res Clin Pract*. 2008; 79:E1–E5.
80. Eikenberg, J. D., & Davy, B. M. Prediabetes: A prevalent and treatable, but often unrecognized clinical condition. *J Acad Nutr Diet*. 2013; 113(2):213–218.
81. Galaviz, K. I., Weber, M. B., Suvada, K. et al. Interventions for reversing prediabetes: A systematic review and meta-analysis. *Amer J Prev Med*. 2022. ISSN: 0749-3797, 1873–2607; doi: 10.1016/j.amepre.2021.10.020; PMID: 35151523.
82. Hamman, R. F., et al. Effect of weight loss with lifestyle intervention on risk of diabetes. *Diabetes Care*. 2006; 29:2102–2107.
83. Centers for Disease Control and Prevention. *National Diabetes Statistics Report*. Available at https://www.cdc.gov/diabetes/data/statistics-report/index.html, accessed February 26, 2022.
84. Thornton, P. L., Kumanyika, S. K., Gregg, E. W., et al. New research directions on disparities in obesity and type 2 diabetes. *Ann N Y Acad Sci*. 2020; 1461(1):5–24. doi: 10.1111/nyas.14270. Epub December 3, 2019. PMID: 31793006; PMCID: PMC7159314.
85. American Diabetes Association. Improving care and promoting health in populations: Standards of medical care in diabetes—2023. *Diabetes Care*. 2023; 46(Suppl 1). doi: https://doi.org/10.2337/dc23-S001.
86. Evert, A. B., Dennison, M., Gardner, C. D., et al. Nutrition therapy for adults with diabetes or prediabetes: A consensus report. *Diabetes Care*. 2019; 42:731–754.
87. Davies, M. J., D'Alessio, D. A., Fradkin, J., et al. Management of hyperglycemia in type 2 diabetes, 2018. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care*. 2018; 41:2669–2701.
88. MacLeod, J., Franz, M. J., Handu, D., et al. Academy of Nutrition and Dietetics Nutrition Practice Guideline for Type 1 and Type 2 Diabetes in Adults: nutrition intervention evidence reviews and recommendations. *J Acad Nutr Diet*. 2017; 117:1637–1658.
89. Briggs Early, K., & Stanley, K. Position of the Academy of Nutrition and Dietetics: The role of medical nutrition therapy and registered dietitian nutritionists in the prevention and treatment of prediabetes and type 2 diabetes. *J Acad Nutr Diet*. 2018; 118:343–353.
90. Zafar, M. I., Mills, K. E., Zheng, J., et al. Low glycemic index diets as an intervention for diabetes: A systematic review and meta-analysis. *Am J Clin Nutr*. 2019; 110:891–902.
91. Goldenberg, J. Z., Day, A., Brinkworth, G. D., et al. Efficacy and safety of low and very low carbohydrate diets for type 2 diabetes remission: Systematic review and meta-analysis of published and unpublished randomized trial data. *BMJ*. 2021; 372:m4743.
92. Van Zuuren, E. J., Fedorowicz, Z., Kuijpers, T., et al. Effects of low carbohydrate compared with low-fat diet interventions on metabolic control in people with type 2 diabetes: A systematic review including grade assessments. *Am J Clin Nutr*. 2018; 108:300–331.
93. Colberg, S. R., et al. Exercise and Type 2 Diabetes: The American College of Sports Medicine and the American Diabetes Association: Joint Position Statement. *Diabetes Care*. 2010; 33:1395–1402.
94. Thorp, A. A., et al. Alternating bouts of sitting and standing attenuate postprandial glucose responses. *Med Sci Sports Exerc*. 2014; 46:2053–2061.
95. Vondra, K., & Hampl, R. Vitamin D and new insights into pathophysiology of type 2 diabetes. *Horm Mol Biol Clin Investig*. 2021; 42(2):203–208. doi: 10.1515/hmbci-2020-0055. PMID: 33655734.
96. Suksomboon, N., Poolsup, N., & Yuwanakorn, A. Systematic review and meta-analysis of the efficacy and safety of chromium supplementation in diabetes. *J Clin Pharm Ther*. 2014; 39(3):292–306. doi: 10.1111/jcpt.12147. Epub March 17, 2014. PMID: 24635480.
97. World Cancer Research Fund/American Institute for Cancer Research. *Diet, Nutrition, Physical Activity and Cancer: A Global Perspective, Continuous Update Project Expert Report 2020-2021*. Available at dietandcancerreport.org, accessed February 28, 2022.
98. Doose, M., Mollica, M. A., Attai, D. J., et al. Identifying and describing cancer survivors: Implications for cancer survivorship research and clinical care. *Cancer*. 2022; 128(2):383–390. doi: 10.1002/cncr.33937. Epub 2021 Oct 1. PMID: 34597418; PMCID: PMC8738118.
99. American Cancer Society. *Cancer Facts & Figures 2022*. Atlanta, GA: American Cancer Society; 2022. Available at www.cancer.org, accessed February 28, 2022.
100. Singh, S., & Sridhar, P. A narrative review of sociodemographic risk and disparities in screening, diagnosis, treatment, and outcomes of the most common extrathoracic malignancies in the United States. *J Thor Dis*. 2021; 13(6):3827–3843. http://dx.doi.org/10.21037/jtd-21-87.
101. Smith, L. A., et al. Translating mechanism-based strategies to break the obesity-cancer link: A narrative review. *J Acad Nutr Diet*. 2018; 118:652–667.
102. Barone, I., Caruso, A., Gelsomino, L., et al. Obesity and endocrine therapy resistance in breast cancer: Mechanistic insights and perspectives. *Obes Rev*. 2022; 23(2):e13358. doi: 10.1111/obr.13358. Epub September 24, 2021. PMID: 34559450.
103. Romaquera, D., et al. Is concordance with the World Cancer Research Fund/American Institute for Cancer Research guidelines for cancer prevention related to subsequent risk of cancer? Results from the EPIC study. *Am J Clin Nutr*. 2012; 96:150–163.
104. Papadimitriou, N., Markozannes, G., Kanellopoulou, A., et al. An umbrella review of the evidence associating diet and cancer risk at 11 anatomical sites. *Nat Commun*. 2021; 12(1):4579. doi: 10.1038/s41467-021-24861-8. PMID: 34321471; PMCID: PMC8319.
105. Eheman, C., et al. Annual Report to the Nation on the Status of Cancer, 1975–2008, Featuring cancers associated with excess weight and lack of sufficient physical activity. *Cancer*. May 1, 2012; 118(9):2338–2366. Epub March 28, 2012.
106. National Cancer Institute. *Nutrition in Cancer Care (PDQ)-Health Professional Version*. PDQ Cancer Information Summaries [Internet]. Bethesda, MD: U.S. National Cancer Institute, Updated January 4, 2022.
107. Milliron, B. J., Packel, L., Dychtwald, D., et al. When eating becomes torturous: Understanding nutrition-related cancer treatment side effects among individuals with cancer and their caregivers. *Nutrients*. 2022; 14(2):356. doi: 10.3390/nu14020356. PMID: 35057538; PMCID: PMC8781744.

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References

108. Bordignon, C., Dos Santos, B. S., & Rosa, D. D. Impact of cancer cachexia on cardiac and skeletal muscle: Role of exercise training. *Cancers (Basel)*. 2022; 14(2):342. doi: 10.3390/cancers14020342. PMID: 35053505; PMCID: PMC8773522.
109. Demark-Wahnefried, W., et al. Weight management and physical activity throughout the cancer care continuum. *CA Cancer J Clin*. 2018; 68(1):64–89. doi: 10.3322/caac.21441. Epub November 22, 2017.
110. National Cancer Institute. *PDQ Cancer Information Summaries: Integrative, Alternative, and Complementary Therapies*. Available at https://www.cancer.gov/publications/pdq/information-summaries/cam, accessed February 28, 2022.

Chapter 18

1. Administration for Community Living: *2020 Profile of Older Americans*. U.S. Department of Health and Human Services, May 2021. Available at https://acl.gov/aging-and-disability-in-america/data-and-research/profile-older-americans, accessed February 6, 2022.
2. Barrett, L. L. Healthy @ Home, AARP Knowledge Management. 2008. Available at http://assets.aarp.org/rgcenter/il/healthy_home.pdf, accessed February 4, 2022.
3. Position of the Academy of Nutrition and Dietetics: Food and nutrition for older adults: Promoting health and wellness. *J Acad Nutr Diet*. 2012; 112:1255–1277.
4. Anderson, A. L., et al. Dietary patterns and survival of older adults. *J Am Diet Assoc*. 2011; 111:84–91.
5. Trichopoulou, A., et al. Anatomy of health effects of Mediterranean diet: Greek EPIC prospective cohort study. *Br Med J*. 2009; 338:b2337.
6. King, D. E., et al. Turning back the clock: Adopting a healthy lifestyle in middle age. *Am J Med*. 2007; 120:598–603.
7. American College of Sports Medicine, Position Stand. Exercise and physical activity for older adults. *Med Sci. Sports Exerc*. 2009; 41:1510–1530.
8. Heron, M. Deaths: Leading causes for 2019. *National Vital Statistics Reports*. 70(9). Hyattsville, MD: National Center for Health Statistics. 2021. doi: https://dx.doi.org/10.15620/cdc:107021.
9. Murphy, S. L., Kochanek, K. D., Xu, J. Q., & Arias, E. Mortality in the United States, 2020. NCHS Data Brief, no. 427. Hyattsville, MD: National Center for Health Statistics. 2021. doi: https://dx.doi.org/10.15620/cdc:112079, accessed February 6, 2022.
10. Parker Health Group, June 13, 2019, *New Parker Study Unveils Disparities in People's Views of Aging* [Press Release]. Available at https://www.parkerlife.org/news/2019/new-parker-study-unveils-disparities-in-people-s-views-of-aging, accessed February 5, 2022.
11. U.S. Census Bureau, June 25, 2020, *65 and Older Population Grows Rapidly as Baby Boomers Age*. Available at https://www.census.gov/newsroom/press-releases/2020/65-older-population-grows, l, accessed February 6, 2022.
12. 1995 White House Conference on Aging. The road to aging policy for the 21st Century. Washington, DC: U.S. National Commission on Libraries, 1996.
13. van Hoof, J., & Kazak, J. K. Urban ageing. *Indoor and Built Environment*, 2018; 27:583–586.
14. Hayflick, L. How and why we age. *Exp Gerontol*. 1998; 33:639–653.
15. Gerontology Research Group. GRG World Supercentenarian Rankings List. Available at https://grg.org/WSRL/TableE.aspx, accessed February 9, 2022.
16. *Healthy People 2030: Building a healthier future for all*. Available at https://health.gov/healthypeople, accessed February 9, 2022.
17. Passarino, G., De Rango, F., & Montesanto, A. (2016). Human longevity: Genetics or Lifestyle? It takes two to tango. *Immunity & Ageing*. 13, 12. https://doi.org/10.1186/s12979-016-0066-z.
18. Forbes, G. B. *Human Body Composition: Growth, Aging, Nutrition, and Activity*. New York, NY: Springer-Verlag, 1987:31.
19. Buys, C. H. Telomeres, telomerase, and cancer. *N Engl J Med*. 2000; 342:1282–1283. Chakravarti, D., LaBella, K. A., & DePinho, R. A. Telomeres: history, health, and hallmarks of aging. *Cell*. 2021; 184:306–322. https://doi.org/10.1016/j.cell.2020.12.028
20. Weindruch, R., & Sohal, R. S. Seminars in medicine of the Beth Israel Deaconess Medical Center. Caloric intake and aging. *N Engl J Med*. 1997; 337:986–994.
21. McCay, C., et al. The effect of retarded growth upon the length of life span and upon the ultimate body size. *J Nutr*. 1935; 10:63–79.
22. Colman, R. J., et al. Caloric restriction delays disease onset and mortality in Rhesus monkeys. *Science*. 2009; 325:201–204.
23. Mattison, J. A., et al. Impact of caloric restriction on health and survival in rhesus monkeys from the NIA study. *Nature*. 2012; 489:318–321.
24. Colman, R. J., et al. Caloric restriction reduces age-related and all-cause mortality in rhesus monkeys. *Nat. Commun*. 2014; 5:3557. doi: 10.1038/ncomms4557.
25. Walford, R. L., et al. Calorie restriction in biosphere 2: Alterations in physiologic, hematologic, hormonal, and biochemical parameters in humans restricted for a 2-year period. *J Gerontol A Biol Sci Med Sci*. 2002; 57:B211–224.
26. Fontana, L., et al. Effect of long-term calorie restriction with adequate protein and micronutrients on thyroid hormones. *J Clin Endocrine Metab*. 2006; 91:3232–3235.
27. Willcox, B. J., et al. Caloric restriction, the traditional Okinawan diet, and healthy aging. The diet of the world's longest-lived people and its potential impact on morbidity and life span. *Ann NY Acad Sci*. 2007; 1114:434–455.
28. Guo, S. S., et al. Aging, body composition, and lifestyle: The Fels Longitudinal Study. *Am J Clin Nutr*. 1999; 70:405–411.
29. Wilmore, J. H., et al. Alterations in body weight and composition consequent to 20 weeks of endurance training: The HERITAGE Family Study. *Am J Clin Nutr*. 1999; 70:346–352.
30. Fiatarone, M. A., et al. High-intensity strength training in nonagenarians: Effects on skeletal muscle. *J Am Med Assoc*. 1990; 263:3029–3034.
31. Villareal, D. T., et al. Obesity in older adults: Technical review and position statement of the American Society for Nutrition and NAASO, The Obesity Society. *Obes Res*. 2005; 13:1849–1863.
32. Forbes, G. B. Longitudinal changes in adult fat-free mass: Influence of body weight. *Am J Clin Nutr*. 1999; 70:1025–1031.
33. Elahi, V. K., et al. A longitudinal study of nutritional intake in men. *J Gerontol*. 1983; 38:162–180.
34. DeVere, R., & Calvert, M. *Navigating Smell and Taste Disorders*. New York: Demos Medical Publishing, 2011.
35. Murphy, C., et al. Prevalence of olfactory impairment in older adults. *J Am Med Assoc*. 2002; 288:2307–2312.
36. Schiffman, S. Changes in taste and smell: Drug interactions and food preferences. *Nutr Rev*. 1994; 52:S11–S14.
37. Dye, B. A, et al. Dental caries and tooth loss in adults in the United States, 2011–2012. NCHS data brief, no. 197. Hyattsville, MD: National Center for Health Statistics. 2015. Available at https://www.cdc.gov/nchs/products/databriefs/db197.htm?_ga=2.243078347.895580566.1594044206-931947627.1591272461, accessed February 10, 2022.
38. Sahyoun, N. R., et al. Nutritional status of the older adult is associated with dentition status. *J Am Diet Assoc*. 2003; 103:61–66.
39. Peng, J., et al. The relationship between tooth loss and mortality from all causes, cardiovascular diseases, and coronary heart disease in the general population: systematic review and dose-response meta-analysis of prospective cohort studies. *Bioscience reports*, 2019; 39: BSR20181773. https://doi.org/10.1042/BSR20181773.
40. Academy of Nutrition and Dietetics. Position of the Academy of Nutrition and Dietetics: Oral health and nutrition. *J Acad Nutr Diet*. 2013; 113:693–701.
41. Roberts, S. B., et al. Control of food intake in older men. *J Am Med Assoc*. 1994; 272:1601–1606.
42. Rolls, B. J. Regulation of food and fluid intake in the elderly. *Ann N Y Acad Sci*. 1989; 561:217–225.
43. Phillips, P. A., et al. Disturbed fluid and electrolyte homoeostasis following dehydration in elderly people. *Age Ageing*. 1993; 22:S26–S33.
44. Phillips, P. A., et al. Reduced thirst after water deprivation in healthy elderly men. *N Engl J Med*. 1984; 311:753–759.

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References

45. Hooper L., et al. Water-loss dehydration and aging. *Mech Ageing Dev*. 2014; 136–137:50–58.
46. Vaudin, A., et al. Sodium and potassium intake, the sodium to potassium ratio, and associated characteristics in older adults, NHANES 2011–2016. *J Acad Nutr Diet*. 2022; 122:64–77. https://doi.org/10.1016/j.jand.2021.06.012.
47. White, J. V., et al. Nutrition screening initiative: Development and implementation of the public awareness checklist and screening tools. *J Am Diet Assoc*. 1992; 92:163–167.
48. White, J. V., et al. Consensus of the Nutrition Screening Initiative: Risk factors and indicators of poor nutritional status in older Americans. *J Am Diet Assoc*. 1991; 91:783–787.
49. Posner, B. M., et al. Nutrition and health risks in the elderly: The nutrition screening initiative. *Am J Public Health*. 1993; 83:972–978.
50. Dixon, L. B., et al. Dietary intakes and serum nutrients differ between adults from food-insufficient and food-sufficient families: Third National Health and Nutrition Examination Survey, 1988–1994. *J. Nutr*. 2001; 131:1232–1246.
51. Lee, J. S., & Frongillo, E. A. Nutritional and health consequences are associated with food insecurity among U.S. elderly persons. *J. Nutr* 2001; 131:1503–1509.
52. Bowman, S. A. Socioeconomic characteristics, dietary and lifestyle patterns, and health and weight status of older adults in NHANES 1999–2002: A comparison of Caucasians and African Americans. *J Nutr Elderly*. 2009; 28:30–46.
53. Martin, C. B., et al. Prescription drug use in the United States, 2015–2016. NCHS Data Brief, no 334. Hyattsville, MD: National Center for Health Statistics. 2019. Available at https://www.cdc.gov/nchs/products/databriefs/db334.htm, accessed February 14, 2022.
54. The American Geriatrics Society 2012 Beers Criteria Update Expert Panel. American Geriatrics Society updated Beers criteria for potentially inappropriate medication use in older adults. *J Am Geriatr Soc*. 2012; 60:616–631.
55. Sahyoun, N. R., & Zhang, X. L. Dietary quality and social contact among a nationally representative sample of the older adult population in the United States. *J Nutr Health Aging*. 2005; 9:177–183.
56. De Castro, J. M. Social facilitation of food intake: People eat more with other people. *Food Nutr News*. 1994; 66:29–30.
57. Gerrior, S. A., et al. How does living alone affect dietary quality? U.S. Department of Agriculture, ARS, Home Economics Research Report No. 51. *Fam Econ Nutr Rev*. 1995; 8:44–46.
58. Sahyoun, N. R., et al. Nutrition Screening Initiative checklist may be a better awareness/educational tool than a screening one. *J Am Diet Assoc*. 1997; 97:760–764.
59. Cereda, E., et al. The ability of the Geriatric Nutritional Risk Index to assess the nutritional status and predict the outcome of home-care resident elderly: A comparison with the Mini-Nutritional Assessment. *Br J of Nutr*. 2009; 1–8.
60. Malnutrition Advisory Group standing committee of BAPEN, *Malnutrition Universal Screening Tool (MUST)*. Available at https://www.bapen.org.uk/screening-and-must/must/introducing-must#, accessed February 15, 2022.
61. Dwyer, J. T., et al. Screening Community-Living Older Adults for Protein Energy Malnutrition and Frailty: Update and Next Steps. *J Community Health*. 2020; 45, 640–660. https://doi.org/10.1007/s10900-019-00739-1.
62. U.S. Department of Agriculture and U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2020-2025*, 9th ed. December 2020. Available at DietaryGuidelines.gov, accessed February 15, 2022.
63. Krok-Schoen, Jessica L., et al. Nutrient intakes from meals and snacks differ with age in middle-aged and older Americans. *Nutrients*. 2019; 11(6):1301.
64. USDA Food Surveys Research Group. What we eat in America, NHANES 2017–2018. Available at https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/food-surveys-research-group/docs/wweia-data-tables/, accessed May 13, 2022.
65. USDA, Agricultural Research Service, 2021. Usual Nutrient Intake from Food and Beverages, by Gender and Age, What We Eat in America, NHANES 2015–2018. Available at https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/food-surveys-research-group/docs/wweia-data-tables/, accessed May 10, 2022.
66. National Academies of Sciences, Engineering, and Medicine. 2023. Dietary Reference Intakes for Energy. Washington, DC: The National Academies Press. https://doi.org/10.17226/26818.
67. Arcerio, P. J., et al. A practical equation to predict resting metabolic rate in older men. *Metabolism*. 1993; 42:950–957.
68. Arcerio, P. J., et al. A practical equation to predict resting metabolic rate in older females. *J Am Geriatric Soc*. 1994; 41:389–395.
69. Taylor, H. L., et al. A questionnaire for the assessment of leisure-time physical activities. *J Chronic Dis*. 1978; 31:741–755.
70. Dawson-Hughes, B., et al. Alkaline diets favour lean tissues in older adults. *Am J Clin Nutr*. 2008; 87:662–665.
71. Campbell, W. W., et al. Dietary protein requirements of younger and older adults. *Am J Clin Nutr*. 2008; 88:1322–1329.
72. Rand, W. M., et al. Meta-analysis of nitrogen balance studies for estimating protein requirements in healthy adults. *Am J Clin Nutr*. 2003; 77:109–127.
73. Paddon-Jones, D., et al. Protein and health aging. *Am J Clin Nutr*. 2015; 101:1339S–1345S.
74. Paddon-Jones, D., et al. Role of dietary protein in the sarcopenia of aging. *Am J Clin Nutr*. 2008; 87(suppl.):1562S–1566S.
75. Symons, T. B., et al. A moderate serving of high-quality protein maximally stimulates skeletal muscle protein synthesis in young and elderly subjects. *J Am Diet Assoc*. 2009; 109:1582–1586.
76. Arnett, D. K., et al. 2019 ACC/AHA guideline on the primary prevention of cardiovascular disease: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol*. 2019; 74:e177–e232.
77. Vivekananthan, D. P., et al. Use of antioxidant vitamins for the prevention of cardiovascular disease: Meta-analysis of randomised trials. *Lancet*. 2003; 361:2017–2023.
78. Weaver, C. M., & Fleet, J. C. Vitamin D requirements: Current and future. *Am J Clin Nutr*. 2004; 80(suppl.):1735S–1739S.
79. Holick, M. F., & Chen, T. C. Vitamin D deficiency: A worldwide problem with health consequences. *Am J Clin Nutri*. 2008; 87(Suppl):1080S–1086S.
80. Webb, A. R., et al. Influence of season and latitude on the cutaneous synthesis of vitamin D3: Exposure to winter sunlight in Boston and Edmonton will not promote vitamin D3 synthesis in human skin. *J Clin Endocrinol Metab*. 1988; 67:373–378.
81. Bischoff-Ferrari, H. A., et al. Estimation of optimal concentrations of 25-hydroxyvitamin D for multiple health outcomes. *Am J Clin Nutr*. 2006; 84:18–28.
82. Meydani, M. Effect of functional food ingredients: Vitamin E modulation of cardiovascular diseases and immune status in the elderly. *Am J Clin Nutr*. 2000; 71:1665S–1668S.
83. Sano, M., et al. A controlled trial of selegiline, alpha-tocopherol, or both as treatment for Alzheimer's disease. The Alzheimer's Disease Cooperative Study. *N Engl J Med*. 1997; 336:1216–1222.
84. Miller, E. R., et al. Meta-analysis: High-dosage vitamin E supplementation may increase all-cause mortality. *Ann Intern Med*. 2005; 142:37–46.
85. Vermeer C. Vitamin K: The effect on health beyond coagulation-an overview. *Food Nutrition Res*. 2012; 56:5329. doi: 10.3402/fnr.v56i0.5329.
86. Mott, A., Bradley, T., Wright, K., et al. Effect of vitamin K on bone mineral density and fractures in adults: an updated systematic review and meta-analysis of randomized controlled trials. *Osteoporos Int*. 2019; 30:1543–1559.
87. Marcason, W. Vitamin K: What are the current dietary recommendations for patients taking Coumadin? *J Am Diet Assoc*. 2007; 107:2022.
88. Jayedi A., & Zargar, M. S. Intake of vitamin B6, folate, and vitamin B12 and risk of coronary heart disease: a systematic review and dose-response meta-analysis of prospective cohort studies. *Crit Rev Food Sci Nutr*. 2019; 59(16).

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References

89. Institute of Medicine (US) Committee to Review Dietary Reference Intakes for Vitamin D and Calcium; Ross, A. C., Taylor, C. L., Yaktine, A. L., et al. (Eds.), *Dietary Reference Intakes for Calcium and Vitamin D*. Washington, DC: National Academies Press, 2011. Available at https://www.ncbi.nlm.nih.gov/books/NBK56070/. doi: 10.17226/13050.
90. Appel, L. J., et al. A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. *N Engl J Med*. 1997; 336:1117–1124.
91. Mursu, J., et al. Less is more: Dietary supplements and mortality rate in older women. The Iowa Women's Health Study. *Arch Intern Med*. 2011; 171:1625–1633.
92. Park, S-Y et al. Multivitamin use and the risk of mortality and cancer incidence The Multiethnic Cohort Study. *Am J Epidemiol*. 2011; 173:906–914.
93. Multivitamin/mineral supplements Fact Sheet for Health Professional. Available at https://ods.od.nih.gov/factsheets/MVMS-HealthProfessional/, accessed March 2, 2022.
94. Prasad, A. S., et al. Zinc supplementation decreases incidence of infections in the elderly: Effect of zinc on generation of cytokines and oxidative stress. *Am J Clin Nutr*. 2007; 85:837–844.
95. Barringer, T. A., et al. Effect of a multivitamin and mineral supplement on infection and quality of life: A randomized, double-blind, placebo-controlled trial. *Ann Intern Med*. 2003; 138:365–371.
96. El-Kadiki, A., & Sutton, A. J. Role of multivitamins and mineral supplements in preventing infection in elderly people: Systematic review and meta-analysis of randomised controlled trials. *Brit Med J*. 2005; 330(7496):871. doi:10.1136/bmj.38399.495648.8F.
97. National Institutes of Health, State-of-the-Science conference statement. Multivitamin/mineral supplements and chronic disease prevention. *Ann Intern Med*. 2006; 145.
98. Bjelakovic, G., Nikolova, D., & Gluud, L. L., et al. Antioxidant supplements for prevention of mortality in healthy participants and patients with various diseases. *Cochran Db Syst Rev*. 2008; 2. Art. No.:CD007176. doi:10.1002/14651858.CD007176.
99. Silver, H. J. Oral strategies to supplement older adults' dietary intakes: comparing the evidence. *Nutr Rev*. 2009; 67:21–31.
100. Mishra, S., Stierman, B., Gahche, J. J., & Potischman, N. Dietary supplement use among adults: United States, 2017–2018. NCHS Data Brief, No. 399. Hyattsville, MD: National Center for Health Statistics, 2021.
101. Schwingshackl, L., Boeing, H., Stelmach-Mardas, M., Gottschald, M., Dietrich, S., Hoffmann, G., Chaimani, A. Dietary supplements and risk of cause-specific death, cardiovascular disease, and cancer: A systematic review and meta-analysis of primary prevention trials. *Adv Nutr*. 2017; 8(1):27–39. https://doi.org/10.3945/an.116.013516.
102. Ernst, E. Commentary How much of CAM is based on research evidence? *Evidence-Based Comp Alter Med*.2011; Article ID 676490, 3 pages. doi:10.1093/ecam/nep044.
103. U.S. Department of Health and Human Services. *Physical Activity Guidelines for Americans,* 2nd ed. Washington, DC: U.S. Department of Health and Human Services; 2018.
104. Krinke, U. B. Effective nutrition education strategies to reach older adults. In Watson, R. R. (ed.), *Handbook of nutrition in the aged*. Boca Raton, FL: CRC Press, 2001:319–331.
105. Friedman, H. S., & Martin, L. R. *The Longevity Project: Surprising Discoveries for Health and Long Life from the Landmark Eight Decade Study*. New York: Hudson Street Press, 2011.
106. Position of the Academy of Nutrition and Dietetics: Food and Nutrition for Older adults: Promoting Health and Wellness. *J Acad Nutr Diet*. 2019; 119:1188–1204.
107. Congressional Research Service. Older Americans Act: Nutrition Services Program. May 4, 2020. Available at https://crsreports.congress.gov/product/pdf/IF/IF10633, accessed May 10, 2022.
108. Senior Hunger and the Older Americans Act: Hearings before the Subcommittee on Primary Health and Aging, of the Senate Committee on Health, Education, Labor and Pensions, 106th Cong. (2011) (Testimony of Kathy Greenlee). Available at http://www.hhs.gov/asl/testify/2011/06/t20110621a.html, accessed June 13, 2015.
109. Sahyoun, N. R., & Vaudin, A. Home-delivered meals and nutrition status among older adults. *Nutr Clin Pract*. 2014; 29:459–465.
110. Sakr-Ashour, F., Wambogo, E., Song, H., & Sahyoun, N. Home-delivered meal participants may be at greater risk of malnutrition without the meal program. *Public Health Nutr*. 2021, 1–23.
111. Buettner, D. *The Blue Zone: Lessons for Living Longer from the People Who've Lived the Longest*. Washington, DC: National Geographic Society, 2008.

Chapter 19

1. Kagawa, Y. From clock genes to telomeres in the regulation of healthspan. *Nutr Rev*. 2012; 70:459–471.
2. Federal Interagency Forum on Aging-Related Statistics. *Older Americans 2020: Key Indicators of Well-Being. Federal Interagency Forum on Aging-Related Statistics*. 2020. Washington, DC: U.S. Government Printing Office. Available at https://agingstats.gov/index.html, accessed March 14, 2022.
3. Medicare Program. *Revisions to Payment Policies and Five-Year Review of and Adjustments to the Relative Values Units Under the Physician Fee Schedule for Calendar Year 2002: Final Rule Subpart G—Medical Nutrition Therapy*. Federal Register, 42 *CFR*, Part 405; 66(212). November 1, 2001; 55275–55281.
4. Lacey, K., & Pritchett, E. Nutrition care process and model: ADA adopts road map to quality care and outcomes management. *J Am Diet Assoc*. 2003; 103(8):1061–1072.
5. American Dietetic Association Position Paper. Cost effectiveness of medical nutrition therapy. *J Am Diet Assoc*. 1995; 95:88–91.
6. Saunders, J., & Smith, T. Malnutrition: Causes and consequences. *Clin Med*. 2010; 10:624–627.
7. Position of the American Dietetic Association: Integration of medical nutrition therapy and pharmacotherapy. *J Am Diet Assoc*. 2010; 110:950–956.
8. Wolinsky, F. D., et al. Health services utilization among the noninstitutionalized elderly. *J Health Soc Behav*. 1983; 24:325–337.
9. Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. *Leading Causes of Death Reports, 1981–2020, United States, 2022*. Available at http://www.cdc.gov/injury/wisqars/leadingcauses.html, accessed March 14, 2022.
10. Freid, V. M., et al. *Multiple Chronic Conditions among Adults Aged 45 and Over: Trends in the Past 10 Years*. NCHS Data Brief, No. 100. Hyattsville, MD: National Center for Health Statistics, 2012.
11. Messier, S. P., et al. Weight loss reduces knee-joint loads in overweight and obese older adults with knee osteoarthritis. *Arthr Rheumat*. 2005; 52:2026–2032.
12. Yates, L. B., et al. Exceptional longevity in men: Modifiable risk factors associated with survival and function to age 90 years. *Arch Intern Med*. 2008; 168:284–290.
13. Imamura, F., et al. Adherence to 2005 Dietary Guidelines for Americans is associated with a reduced progression of coronary artery atherosclerosis in women with established coronary artery disease. *Am J Clin Nutr*. 2009; 90:193–201.
14. National Center for Health Statistics. *Health, United States, 2019*. Hyattsville, MD. 2021. doi: https://dx.doi.org/10.15620/cdc:100685.
15. Virani, S. S., et al. on behalf of the American Heart Association Council on Epidemiology and Prevention Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics—2021 update: A report from the American Heart Association. *Circulation*. 2021; 143:e254–e743. doi: 10.1161/CIR.0000000000000950. Available at https://www.ahajounals.org/doi/epub/10.1161/CIR.0000000000000950, accessed March 15, 2022.
16. Odden, M. C., et al. Risk factors for cardiovascular disease across the spectrum of older age: The Cardiovascular Health Study. *Atherosclerosis*. 2014; 237:336–342.
17. Arnett, D. K., et al. 2019 ACC/AHA guideline on the primary prevention of

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References

cardiovascular disease: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol*. 2019; 74:e177–232.

18. Lichtenstein, A. H., et al. 2021 Dietary Guidance to Improve Cardiovascular Health: A Scientific Statement From the American Heart Association. *Circulation*. 2021; 144:e472–e478. doi: 10.1161/CIR.0000000000001031.
19. Aung, T., et al. Associations of omega-3 fatty acid supplement use with cardiovascular disease risks meta-analysis of 10 trials involving 77 917 individuals. *JAMA Cardiol*. 2018; 3:225-234. doi:10.1001/jamacardio.2017.5205.
20. Hu, F. B., & Manson, J. E. Omega-3 fatty acids and the secondary prevention of cardiovascular disease—Is it just a fish tale? (comment). *Arch Intern Med*. 2012; 172:694–696.
21. Easton, D., et al. Definition and evaluation of transient ischemic attack. *Stroke*. 2009; 40:2276–2293.
22. Bhatt, H., et al. Coronary heart disease risk factors and outcomes in the twenty-first century: Findings from the Reasons for Geographic and Racial Differences in Stroke (REGARDS) Study. *Curr Hypertens Rep*. 2015; 17:541.
23. Sacco, R. L., et al. The protective effects of moderate alcohol consumption on ischemic stroke. *J Amer Med Assoc*. 1999; 281:53–60.
24. Millwood, I. Y. et al. Conventional and genetic evidence on alcohol and vascular disease aetiology: A prospective study of 500 000 men and women in China. *The Lancet*. 2019; no. 393 10183:1773–1910.
25. Meschia, J. F., et al. Guidelines for the primary prevention of stroke: A statement for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*. 2014; 45:3754–3832.
26. James, P. A. 2014 evidence-based guideline for the management of high blood pressure in adults. Report from the panel members appointed to the Eighth Joint National Committee (JNC 8). *J Amer Med Assoc*. 2014; 311:507–520.
27. Whelton, P. K, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: executive summary: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Hypertension*. 2017; 23976. doi: 10.1016/j.jacc.2017.07.745.
28. Xu, J., et al. *Deaths: Final Data for 2019. National Vital Statistics Reports*. Vol. 70, No 8. Hyattsville, MD: National Center for Health Statistics, 2021.
29. Drenjančević-Perić, I., et al. High-salt diet and hypertension: Focus on the renin-angiotensin system. *Kidney Blood Press Res*. 2011; 34:1–11. doi:10.1159/000320387.
30. Oparil, S., et al. Hypertension. *Nat Rev Dis Primers*. 2018; 4:18014. doi:10.1038/nrdp.2018.14.
31. Fu, J., et al. Nonpharmacologic interventions for reducing blood pressure in adults with prehypertension to established hypertension. *J Am Heart Assoc*. 2020; 9:e016804. https://doi.org/10.1161/JAHA.120.016804, accessed March 21, 2022.
32. Filippou, C. D. et al. Dietary Approaches to Stop Hypertension (DASH) diet and blood pressure reduction in adults with and without hypertension: A systematic review and meta-analysis of randomized controlled trials. *Adv Nutr*. 2020; 11:1150–1160.
33. Sacks, F. M., et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. *N Engl J Med*. 2001; 344:3–10.
34. Welty, F. K., et al. Effect of onsite dietician counseling on weight loss and lipid levels in an outpatient physician office. *Am J Cardiol*. 2007; 100:73–75.
35. Folsom, A. R., et al. Degree of concordance with DASH diet guidelines and incidence of hypertension and fatal cardiovascular disease. *Am J Hypertens*. 2007; 20:225–232.
36. Levitan, E. B., et al. Consistency with the DASH diet and incidence of heart failure. *Arch Intern Med*. 2009; 169:851–857.
37. Centers for Disease Control and Prevention. *National Diabetes Statistics Report, 2020*. Atlanta, GA: Centers for Disease Control and Prevention, U.S. Department of Health and Human Services; 2020. Available at https://www.cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf, accessed March 21, 2022.
38. American Diabetes Association Professional Practice Committee. 13. Older adults: Standards of medical care in diabetes—2022. *Diabetes Care*. 2022; 45(suppl. 1):S195–S207.
39. Schwartz, A. V., et al. Diabetes-related complications, glycemic control, and falls in older adults. *Diabetes Care*. 2008; 31:391–396.
40. American Diabetes Association Professional Practice Committee. 5. Facilitating behaviour change and well-being to improve health outcomes: Standards of Medical Care in Diabetes—2022. *Diabetes Care*. 2022; 45(suppl. 1):560–582.
41. Jensen, M. D., et al. 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society. *Circulation*. 2014; 129:S102–S138.
42. World Health Organization Consultation on Obesity. *Obesity: Preventing and Managing the Global Epidemic*. Geneva, Switzerland: World Health Organization, 2000; WHO Technical Report Series 894.
43. Heiat, A., et al. An evidence-based assessment of federal guidelines for overweight and obesity as they apply to elderly persons. *Arch Intern Med*. 2001; 161:1194–1203.
44. Wharton, S., et al. Obesity in adults: a clinical practice guideline. *CMAJ*. 2020; 192:E875–E891. doi: 10.1503/cmaj.191707.
45. Flegal, K. M., et al. Association of all-cause mortality with overweight and obesity using standard body mass index categories: A systematic review and meta-analysis. *J Amer Med Assoc*. 2013; 309:71–82.
46. Winter J. E., et al. BMI and all-cause mortality in older adults: A meta-analysis. *Am J Clin Nutr*. 2014; 99:875–890.
47. Price, G. M., et al. Weight, shape, and mortality risk in older persons: Elevated waist–hip ratio, not high body mass index, is associated with a greater risk of death. *Am J Clin Nutr*. 2006; 84:449–460.
48. Pischon, T., et al. General and abdominal adiposity and risk of death in Europe. *N Eng J Med*. 2008; 359:2105–2120.
49. Winter, Y., et al. Contribution of obesity and abdominal fat mass to risk of stroke and transient ischemic attacks. *Stroke*. 2008; 39:3145–3151.
50. Sui, X., et al. Cardiorespiratory fitness and adiposity as mortality predictors in older adults. *J Amer Med Assoc*. 2007; 298:2507–2516.
51. Beavers, K. M., et al. Is lost lean mass from intentional weight loss recovered during weight regain in postmenopausal women? *Am J Clin Nutr*. 2011; 94:767–774.
52. American College of Sports Medicine, Position Stand, "Exercise and Physical Activity for Older Adults." *Med Sci. Sports Exerc*. 2009; 41: 1510–1530.
53. DeCaria, J. E., et al. Scoping review report: Obesity in older adults. *Int J Obesity*. 2012; 36:1141–1150.
54. National Osteoporosis Foundation. *Bone Basics*. Available at http://www.bonehealthandosteoporosis.org/wp-content/uploads/2016/02/Who-Gets-Osteoporosis.pdf, accessed March 22, 2022.
55. World Health Organization Scientific Group on the assessment of osteoporosis at primary health care level. Summary meeting report, Brussels, Belgium, 5–7 May 2004. Available at http://who.int/chp/topics/Osteoporosis.pdf?ua=1, accessed March 22, 2022.
56. Cosman, F., et al. Clinician's guide to prevention and treatment of osteoporosis. *Osteopos Int*. 2014; 24:2359–2381. doi: 10.1007/s00198-014-2794-2.
57. Sarafrazi, N., et al. Osteoporosis or Low Bone Mass in Older Adults: United States, 2017–2018. NCHS Data Brief, Number 405, March 2021.
58. Coughlan, T., & Dockery, F. Osteoporosis and fracture risk in older people. *Clin Med*. 2014; 14:187–191. doi: 10.7861/clinmedicine.14-2–187.
59. Matkovic, V., et al. Bone status and fracture rates in two regions of Yugoslavia. *Am J Clin Nutr*. 1979; 32:540–549.

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References

60. Lloyd, T., et al. Calcium supplementation and bone mineral density in adolescent girls. *J Am Med Assoc*. 1993; 270:841–844.
61. Burns, E., & Kakara, R. Deaths from Falls Among Persons Aged ≥65 Years—United States, 2007–2016. *MMWR Morb Mortal Wkly Rep*. 2018; 67(18):509–514. doi: 10.15585/mmwr.mm6718a1. Available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5944976/#R2, accessed March 22, 2022.
62. Bischoff-Ferrari, H. A., et al. Fracture prevention with vitamin D supplementation: A meta-analysis of randomized controlled trials. *J Amer Med Assoc*. 2005; 293:2257–2264.
63. Prince, R. L., et al. Effects of calcium supplementation on clinical fracture and bone structure. *Arch Intern Med*. 2006; 166:869–875.
64. Hannan M. T., et al. Effect of dietary protein on bone loss in elderly men and women: The Framingham osteoporosis study. *J Bone Miner Res*. 2000; 15:2504–2512.
65. Rizzoli, R., et al. Benefits and safety of dietary protein for bone health—An expert consensus paper endorsed by the European Society for Clinical and Economical Aspects of Osteopororosis, Osteoarthritis, and Musculoskeletal Diseases and by the International Osteoporosis Foundation. *Osteoporos Int*. 2018; 29:1933–1948. Available at https://doi.org/10.1007/s00198-018-4534-5, accessed March 22, 2022.
66. Burckhardt, P. The effect of the alkali load of mineral water on bone metabolism: Interventional studies. *J Nutr*. 2008; 138:435S–437S.
67. Dawson-Hughes, B., et al. Alkaline diets favour lean tissue mass in older adults. *Am J Clin Nutr*. 2008; 87:662–665.
68. Writing Group for the Women's Health Initiative Investigators. Risks and benefits of estrogen plus progestin in healthy postmenopausal women. Principal results from the Women's Health Initiative randomized controlled trial. *J Am Med Assoc*. 2002; 288:321–333.
69. Rosen, C. J. Serotonin rising—The bone, brain, bowel connection. *N Engl J Med*. 2009; 360:957–959.
70. *QuickStats*: Prevalence of Edentualism in Adults Aged ≥65 Years, by Age Group and Race/Hispanic Origin—National Health and Nutrition Examination Survey, 2011–2014. *MMWR Morb Mortal Wkly Rep*. 2017; 66:94. doi: http://dx.doi.org/10.15585/mmwr.mm6603a12.
71. Sahyoun, N. R., et al. Nutritional status of the older adult is associated with dentition status. *J Am Diet Assoc*. 2003; 103:61–66.
72. Academy of Nutrition and Dietetics. Position of the Academy of Nutrition and Dietetics: Oral health and nutrition. *J Acad Nutr Diet*. 2013; 113:693–701.
73. Eke, P. I., et al. Recent epidemiologic trends in periodontitis in the USA. *Periodontology 2000*. 2020; 82: 257–267.
74. Liccardo, D., et al. Periodontal disease: A risk factor for diabetes and cardiovascular disease. *Int J Mol Sci*. 2019; 20:1414. doi.org/10.3390/ijms20061414.
75. Naqvi, A. Z., et al. n-3 fatty acids and periodontitis in US adults. *J Am Diet Assoc*. 2010; 110:1669–1675.
76. Azzi, D. V., et al. n-3 ingestion may modulate the severity of periodontal disease? Systematic review. *Crit Rev Food Sci Nutr*. 2018; 58:1937–1942, doi: 10.1080/10408398.2017.1278677.
77. Savarino, E., et al. Expert consensus document: Advances in the physiological assessment and diagnosis of GERD. *Nat Rev Gastroenterol Hepatol*. 2017; 14:665–676. doi: 10.1038/nrgastro.2017.130.
78. Zerbib, F., et al. ESNM/ANMS consensus paper: Diagnosis and management of refractory gastro-esophageal reflux disease. *Neurogastroenterol Motil*. 2020; 33:e14075. https://doi.org/10.1111/nmo.14075.
79. Fashner, J., et al. Diagnosis and treatment of peptic ulcer disease and *H. pylori* infection. *Am Fam Physician*. 2015; 91:236–242. Available at www.aafp.org/afp/2007/0201/p351.html, accessed March 29, 2018.
80. Chatthanawaree, W. Biomarkers of cobalamin (vitamin B_{12}) deficiency and its application. *J Nutr Health Aging*. 2011; 15:227–231.
81. Bailey, R. L., et al. Monitoring of vitamin B-12 nutritional status in the United States by using plasma methylmalonic acid and serum vitamin B-12. *Am J Clin Nutr*. 2011; 94:552–561.
82. Otten, J. J., et al. (Eds.). Institute of Medicine of the National Academies. *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements*. Washington, DC: The National Academies Press, 2006.
83. Eussen, S. J. P. M., et al. Oral Cyanocobalamin supplementation in older people with vitamin B_{12} deficiency: A dose-finding trial. *Arch Intern Med*. 2005; 165:1167–1172.
84. Schmulson, M. J. What is new in Rome IV. Neurogastroenterol Motil. 2017; 23:151–163.
85. Gallegos-Orozco, J. F., et al. Chronic constipation in the elderly. *Am J Gastroenterol*. 2012; 107:18–25.
86. Müller-Lissner, S. A., et al. Myths and misconceptions about chronic constipation. *Am J Gastroenterol*. 2005; 100:232–242.
87. Staller, K., & Cash, B. D. Myths and misconceptions about constipation: A new view for the 2020s. *Am J Gastroenterol*. 2020; 115:1741–1745. doi: 10.14309/ajg.0000000000000947.
88. Rao, S. S., & Go, J. T. Update on management of constipation in the elderly: New treatment options. *Clin Interv Aging*. 2010; 5:163–171.
89. Behm, R. M. A special recipe to banish constipation. *Geriatr Nurs*. 1985; 6:216–217.
90. Theis, K. A., et al. Prevalence of arthritis and arthritis-attributable activity limitation—United States, 2016-2018. *MMWR Morb Mortal Wkly Rep*. 2021; 70:1401–1407. doi: http://dx.doi.org/10.15585/mmwr.mm7040a2, accessed March 23, 2022.
91. Zhang, F. F., et al. Vitamin D deficiency is associated with progression of knee osteoarthritis. *J Nutr*. 2014; 144:2002–2008.
92. McAlindon, T., et al. Effect of vitamin D supplementation on progression of knee pain and cartilage volume loss in patients with symptomatic osteoarthritis. *J Amer Med Assoc*. 2013; 309:155–162.
93. Yu, Y., et al. Association between vitamin D and knee osteoarthritis: A PRISMA-compliant meta-analysis. *Z Orthop Unfall*. 2021; 159(3):281–287. doi: 10.1055/a-1098-8815.
94. Cameron, M., et al. Evidence of effectiveness of herbal medicinal products in the treatment of arthritis. Part I: Osteoarthritis. *Phytother Res*. 2009; 23:1497–1515.
95. Marcason, W. What is the anti-inflammatory diet? Question of the month. *J Am Diet Assoc*. 2010; 110:1780.
96. Clegg, D. O., et al. Glucosamine, chondroitin sulphate, and the two in combination for painful knee osteoarthritis. *N Engl J Med*. 2006; 354:795–808.
97. Simental-Mendía, M., et al. Effect of glucosamine and chondroitin sulfate in symptomatic knee osteoarthritis: A systematic review and meta-analysis of randomized placebo-controlled trials. *Rheumatol Int*. 2018; 38:1413–1428. https://doi.org/10.1007/s00296-018-4077-2.
98. Borchers, A. T., et al. Inflammation and Native American medicine: The role of botanicals. *Am J Clin Nutr*. 2000; 72:339–347.
99. Alzheimer's Association. 2022 Alzheimer's disease facts and figures. *Alzheimers Dement*. 2022; 18. Available at https://www.alz.org/media/Documents/alzheimers-facts-and-figures.pdf, accessed March 24, 2022.
100. Jack, Jr., C. R., et al. Introduction to the recommendations from the National Institute on Aging–Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimers Dement*. 2011; 7:257–262.
101. Jack, C. R., et al. NIA-AA Research Framework: Toward a biological definition of Alzheimer's disease. *Alzheimers Dement*. 2018; 14:535-562. doi: 10.1016/j.jalz.2018.02.018.
102. Aisen, P. S., et al. High-dose B vitamin supplementation and cognitive decline in Alzheimer disease: A randomized controlled trial. *J Amer Med Assoc*. 2008; 300:1774–1783.
103. van de Rest, O., et al. Dietary patterns, cognitive decline, and dementia: A systematic review. *Adv Nutr*. 2015; 6:154–168.
104. Feart, C., et al. Adherence to a Mediterranean diet, cognitive decline, and risk of dementia. *J Amer Med Assoc*. 2009; 302:638–648.
105. Xi, C., et al. Dietary patterns and cognitive health in older adults: A systematic review. *J Alzheimers Dis*. 2019; 67:583–619. doi: 10.3233/JAD-180468.

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References

106. Witte, A. V., et al. Caloric restriction improves memory in elderly humans. *P Natl Acad Sci USA*. 2009; 106:1255–1260.
107. Sabia, S., et al. Body mass index over the adult life course and cognition in late midlife: The Whitehall II Cohort study. *Am J Clin Nutr*. 2009; 89:601–607.
108. Williams, J. W., et al. *Preventing Alzheimer's Disease and Cognitive Decline*. Evidence Report/Technology Assessment Number 193. AHRQ Publication No. 10-E005. April 2010.
109. Livingston, G., et al. Dementia prevention, intervention, and care. *Lancet*. 2017; 390:2673–2734.
110. Gnjidic, D., et al. High-risk prescribing and incidence of frailty among older community-dwelling men. *Clin Pharmacol Ther*. 2012; 91:521–528.
111. American Geriatrics Society 2015 Beers Criteria Update Expert Panel. American Geriatrics Society 2015 Updated Beers criteria for potentially inappropriate medication use in older adults. *J Am Geriatr Soc*. 2015; 63:2227–2246.
112. Martin, C. B., et al. Prescription drug use in the United States, 2015–2016. NCHS Data Brief, No. 334. Hyattsville, MD: National Center for Health Statistics, 2019.
113. Douglass, R., & Heckman, G. Drug-related taste disturbance. *Can Fam Physician*. 2010; 56:1142–1147.
114. National Institutes of Health. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults—The evidence report. *Obes Res*. 1998; 6(suppl. 2):51S–209S.
115. The World Health Organization/Food and Agricultural Organization/United Nations University. *Physical Status: The Use and Interpretation of Anthropometry*. Report of a WHO Expert Committee. Geneva: World Health Organization, 1995.
116. National Cancer Institute. SEER-Medicare: Minimum Data Set (MDS)-Nursing Home Assessment. Available at https://healthcaredelivery.cancer.gov/seermedicare/medicare/mds.html, accessed March 23, 2022.
117. Zeanandin, G., et al. Impact of restrictive diets on the risk of undernutrition in a free-living elderly population. *Clin Nutr*. 2012; 31:69–73.
118. Wernette, C. M., et al. Signaling proteins that influence energy intake may affect unintentional weight loss in elderly persons. *J Am Diet Assoc*. 2011; 111:864–873.
119. Saghaleini, S., H., et al. Pressure ulcer and nutrition. *Indian J Crit Care Med*. 2018; 22:283–289. doi: 10.4103/ijccm.IJCCM_277_17.
120. Akner, G., & Cederholm, T. Treatment of protein-energy malnutrition in chronic nonmalignant disorders. *Am J Clin Nutr*. 2001; 74:6–24.
121. Milne, A. C., et al. Protein and energy supplementation in elderly people at risk from malnutrition. *Cochrane Db Syst Rev*. 2002; 4:1–71.
122. Cereda, E., et al. Energy balance in patients with pressure ulcers: A systematic review and meta-analysis of observational studies. *J Am Diet Assoc*. 2011; 111:1868–1876.
123. National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. *Prevention and Treatment of Pressure Ulcers: Quick Reference Guide*. Emily Haesler, ed. Perth, Australia: Cambridge Media, 2014. Available at https://www.epuap.org/wp-content/uploads/2016/10/quick-reference-guide-digital-npuap-epuap-pppia-jan2016.pdf, accessed March 23, 2022.
124. Gross, C. R., et al. Clinical indicators of dehydration severity in elderly patients. *J Emerg Med*. 1992; 10:267–274.
125. Hodgkinson, B., et al. Maintaining oral hydration in older adults: A systematic review. *Int J Nurs Pract*. 2003; 9:S19–S28.
126. Hooper, L., et al. Clinical symptoms, signs and tests for identification of impending and current water-loss dehydration in older people. *Cochrane Database Syst Rev*. 2015; 4. Art. No. CD009647. doi: 10.1002/14651858.CD009647.pub2.
127. Phillips, P. A., et al. Reduced thirst after water deprivation in healthy elderly men. *N Eng J Med*. 1984; 311:753–759.
128. Institute of Medicine of the National Academies. *Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate*. Washington, DC: The National Academies Press, 2005.
129. Cabrera, C., et al. Beneficial effects of green tea—A review. *J Am Coll Nutri*. 2006; 25:79–99.
130. Wang, C. H., et al. Cranberry-containing products for prevention of urinary tract infections in susceptible populations: A systematic review and meta-analysis of randomized controlled trials. *Arch Intern Med*. 2012; 172:988–996.
131. Good, P., et al. Medically assisted hydration for adult palliative care patients. *Cochrane Library*. Published online April 2014. Available at www.cochrane.org/CD006273/SYMPT_medically-assisted-hydration-to-assist-palliative-care-patients, accessed April 1, 2018.
132. Ganzini, L., et al. Nurses' experiences with hospice patients who refuse food and fluids to hasten death. *N Engl J Med*. 2003; 349:359–365.
133. Leming, M. R., & Dickinson, G. E. *Understanding Dying, Death, and Bereavement*. Fort Worth, TX: Holt, Rinehart, and Winston, 1990.
134. Stahl, S. T., & Schulz, R. Changes in routine health behaviors following late-life bereavement: A systematic review. *J Behav Med*. 2014; 37:736–755.

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acinus Small sacs lined by cells that produce milk.

active living movement Building a culture where regular physical activity and healthy eating are the accepted norm for people of all ages, abilities, and income levels. Involves partnerships of public and private entities and the local community to bring about changes.

activity thermogenesis Energy expended through physical activity and nonexercise activity such as fidgeting.

active transport The flow of atoms, ions, or water from lower concentration to higher concentration. This process requires energy and is assisted by enzymes.

adipocytokines Adipose tissue secretes several signaling proteins, including the appetite suppressants adiponectin, leptin, and resistin.

adipose tissue macrophage A type of cell within adipose tissue that switches in response to its microenvironment to be anti-inflammatory or pro-inflammatory.

allele A different version of the same gene. Alleles have a different arrangement of bases than the usual version of the gene.

allergic diseases Conditions resulting from hypersensitivity to a physical or chemical agent.

alveoli A rounded or oblong-shaped cavity present in the breast.

Alzheimer's disease A brain disease that represents the most common form of dementia. It is characterized by memory loss for recent events that expands to more distant memories over the course of 5 to 10 years. It eventually produces profound intellectual decline characterized by dementia and personal helplessness.

amenorrhea Absence of menstrual cycle.

amino acids The "building blocks" of protein. Unlike carbohydrates and fats, amino acids contain nitrogen.

amniotic fluid The fluid contained in the amniotic sac that surrounds the fetus in the uterus.

amylophagia Compulsive consumption of laundry starch or cornstarch.

anaphylaxis Sudden onset of a reaction with mild to severe symptoms, including a decrease in ability to breathe, wheezing, coughing or tightness in chest, which may be severe enough to cause a coma.

androgens Types of steroid hormones produced in the testes, ovaries, and adrenal cortex from cholesterol. Some androgens (testosterone, dihydrotestosterone) stimulate development and functioning of male sex organs.

anemia A reduction below normal in the number of red blood cells per cubic mm in the quantity of hemoglobin, or in the volume of packed red cells per 100 mL of blood. This reduction occurs when the balance between blood loss and blood production is disturbed.

aneurysm Ballooning of the blood vessel wall.

ankyloglossia (tongue-tie) A congenital condition of a tight or short frenulum that causes tongue restriction and range of motion.

anorexia nervosa (AN) An eating disorder characterized by extreme weight loss, poor body image, and irrational fears of weight gain and obesity.

anovulation The absence of ovulation.

anovulatory cycles Menstrual cycles in which ovulation does not occur.

antidiuretic hormone Causes kidneys to absorb more water from urine, resulting in increased blood volume.

antioxidants Chemical substances that prevent or repair damage to molecules and cells caused by oxidizing agents. Vitamins C and E, selenium, and certain components of plants function as antioxidants.

anthropometry The science of measuring the human body and its parts.

antioxidants Chemical substances that prevent or repair damage to cells caused by exposure to oxidizing agents such as oxygen, ozone, and smoke and to other oxidizing agents normally produced in the body. Many different antioxidants are found in foods; some are made by the body.

aphasia Difficulties in self-expression, including inability to speak, finding the right words, or understanding print or spoken words.

appropriate for gestational age (AGA) Weight, length, and head circumference are between the 10th and 90th percentiles for gestational age.

assisted reproductive technology (ART) An umbrella term for fertility treatments such as *in vitro* fertilization (IVF, a technique in which egg cells are fertilized by sperm outside the woman's body), artificial insemination, and hormone treatments.

asthma Condition in which the lungs are unable to exchange air due to lack of expansion of air sacs. It can result in a chronic illness and sometimes unconsciousness and death if not treated.

atherogenic diet A pattern of eating and food choices that promotes deposits of plaque in arterial walls and contributes to the development of cardiovascular disease.

atherosclerosis A type of hardening of the arteries in which cholesterol is deposited in the arteries. These deposits narrow the coronary arteries and may reduce the flow of blood to the heart.

athetosis Uncontrolled movements of the large muscle groups as a result of damage to the central nervous system.

atrial fibrillation Degeneration of the heart muscle causing irregular contractions.

attention deficit hyperactivity disorder (ADHD) Condition characterized by low impulse control and short attention span, with and without a high level of overall activity.

autism spectrum disorders (ASDs) A group of developmental disorders characterized by deficits in communication, social interaction, and behaviors that meet diagnostic criteria in standardized testing, with onset generally before age 3.

autoimmune disease Diseases that result from a failure of an organism to recognize its own constituent parts as "self." The organism attempts to defend itself from the perceived foreign substance through actions of its immune system. These actions can damage molecules, cells, tissues, and organs. Type 1 diabetes, lupus, and rheumatoid arthritis are examples of autoimmune diseases.

B-lymphocytes White blood cells that are responsible for producing immunoglobulins.

basal metabolic rate (BMR) Amount of energy required for cellular metabolic processes and function of organs. It is measured in an individual who has been awake less than 30 minutes and is still at absolute

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rest, has fasted for 10 hours or more, and is in a quiet room with normal, comfortable temperature.

bilirubin encephalopathy or kernicterus The chronic and permanent clinical sequelae that are the end result of very high untreated bilirubin levels. Excessive bilirubin in the system is deposited in the brain, causing toxicity to the basal ganglia and various brainstem nuclei.

binge-eating disorder (BED) An eating disorder characterized by periodic binge eating, which normally is not followed by purging. People must experience eating binges twice a week on average for over 6 months to qualify for this diagnosis.

bioactive food components Constituents in foods or dietary supplements other than those needed to meet basic human nutritional needs that are responsible for changes in health status.

body mass index (BMI) Weight in kg/height in m^2. BMIs < 18.5 are considered underweight, 18.5–24.9 healthy weight, 25–29.9 overweight, and BMIs of 30 and higher obesity.

bone age Bone maturation; correlates well with stage of pubertal development.

bronchopulmonary dysplasia (BPD) Condition in which the underdeveloped lungs in a preterm infant are damaged so that breathing requires extra effort.

bulimia nervosa An eating disorder characterized by recurrent episodes of rapid, uncontrolled eating of large amounts of food in a short period of time. Episodes of binge eating are followed by compensatory behaviors such as self-induced vomiting, dieting, excessive exercise, or misuse of laxatives to prevent weight gain.

cachexia A complex metabolic syndrome characterized by progressive loss of body weight, fat and muscle, systemic inflammation, and negative protein and energy balance.

calorie A unit of measure of the amount of energy supplied by food. Also known as the "kilocalorie" (kcal), or the "large Calorie."

calorie restriction Decreasing the energy level of one's diet by 25–30 percent while meeting protein, vitamin, and mineral needs.

carcinogenesis The process by which normal cells are transformed into cancer cells. It includes activation, initiation, promotion, progression, and invasion and metastasis. Dietary constituents can modify the process at several points along the continuum.

carcinogenic diet A pattern of eating and food choices that increases the risk of some cancers.

cardio-protective diet A diet that emphasizes plant foods (vegetables, fruits, grains, especially whole grains, and legumes), appropriate fats, and fish, along with smaller amounts of lean meat and dairy.

cardiovascular health score (CVH) A composite number based on seven measurable and modifiable medical and behavioral factors related to CVD: total cholesterol, blood pressure, fasting glucose, BMI, diet, physical activity, and smoking.

carotid artery disease Arteries that supply blood to the brain and neck becoming damaged.

catch-up growth The accelerated growth that occurs following a period of restricted or slow growth.

centenarian Person who reaches age 100 or more.

cephalopelvic disproportion A mismatch between the size of the fetal head and size of the maternal pelvis, resulting in "failure to progress" in labor for mechanical reasons.

cerebral embolism Piece of a blood clot formed elsewhere that travels to the brain.

cerebral palsy A group of disorders characterized by impaired muscle activity and coordination present at birth or developed during early childhood.

cerebrovascular disease Conditions caused by problems that affect the blood supply to the brain.

children with special healthcare needs A general term for infants and children with, or at risk for, physical or developmental disabilities or chronic medical conditions from genetic or metabolic disorders, birth defects, premature births, trauma, infection, or prenatal exposure to drugs.

cholesterol A fat-soluble, colorless liquid primarily found in animal products.

chronic condition Disorder of health or development that is the usual state for an individual and unlikely to change, although secondary conditions may result over time.

chronic disease Slow-developing, long-lasting diseases that are not contagious (e.g., heart disease, cancer, diabetes). They can be treated but not always cured.

chronic inflammation Low-grade inflammation that lasts weeks, months, or years. Inflammation is the first response of the body's immune system to infectious agents, toxins, or irritants. It triggers the release of biologically active substances that promote oxidation and other reactions to counteract the infection, toxin, or irritant. A side effect of chronic inflammation is that it also damages lipids, cells, and tissues.

cleft lip and palate Condition in which the upper lip and/or palate are not completely formed and in need of surgical correction. The cleft may contribute to feeding problems in early infancy.

climacteric change Point in life where crucial changes occur; refers to the loss of reproductive activity, marked by menopause in women and reduction in testosterone production in men.

cobalamin Another name for vitamin B_{12}. Important roles of cobalamin are fatty-acid metabolism, synthesis of nucleic acid (i.e., DNA, a complex protein that controls the formation of healthy new cells), and formation of the myelin sheath that protects nerve cells.

coenzymes Chemical substances that activate enzymes.

cognitive behavioral therapy Programs designed to build knowledge, modify beliefs and attitudes, and integrate new behaviors through a combination of skills training and analysis of behavior and thought processes over a period of several weeks. Key features are cognitive restructuring and stimulus control.

cognitive function The process of thinking.

colic A condition marked by a sudden onset of irritability, fussiness, or crying in a young infant between 2 weeks and 3 months of age who is otherwise growing and healthy.

colostrum The milk produced in the first 2–3 days after the baby is born. Colostrum is higher in protein and lower in lactose than milk produced after a milk supply is established.

commodity program A USDA program in which food products are sent to schools for use in the child nutrition programs. Commodities are usually acquired for farm price support and surplus-removal reasons.

comorbidity The presence of one or more diseases or conditions in addition to the primary disease or disorder.

competitive foods Foods sold to children in food service areas during mealtimes that compete with the federal meal programs.

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compression of morbidity Shortening the period of illness and decreased functional capabilities at the end of life.

congenital abnormality A structural, functional, or metabolic abnormality present at birth. Also called congenital anomalies. These may be caused by environmental or genetic factors, or by a combination of the two. Structural abnormalities are generally referred to as congenital malformations, and metabolic abnormalities as inborn errors of metabolism.

congenital anomaly Condition evident in a newborn that is diagnosed at or near birth, usually as a genetic or chronic condition, such as spina bifida or cleft lip and palate.

congenital anomalies Structural, functional, or metabolic abnormalities present at birth. Also called congenital abnormalities.

Continuum of Nutritional Health Stages of nutritional status that range from optimal to unable to sustain life. The stages are resilient and healthy, altered substrate availability, nonspecific signs and symptoms, clinical conditions, chronic conditions, and terminal illness and death.

corpus luteum (*corpus* = body, *luteum* = yellow) A tissue about 12 mm in diameter formed from the follicle that contained the ovum prior to its release. It produces estrogen and progesterone. The "yellow body" derivation comes from the accumulation of lipid precursors of these hormones in the corpus luteum.

critical periods Preprogrammed time periods during embryonic and fetal development when specific cells, organs, and tissues are formed and integrated, or functional levels established. Also called *sensitive periods*.

cytokines Small secreted chemical messenger proteins that function as immunomodulating agents. Some cytokines stimulate the immune system and others slow it down.

daily values (DVs) Scientifically agreed-upon standards for daily intakes of nutrients from the diet developed for use on nutrition labels.

demographic transition Transition from high birth and death rates to low birth and death rates.

development Progression of the physical and mental capabilities of an organism through growth and differentiation of organs and tissues, and integration of functions.

developmental delay Slow to meet or not reaching milestones expected for a child's age in one or more areas of development: communication, motor, cognition, social-emotional, or adaptive skills.

developmental disabilities A group of conditions due to an impairment in physical, learning, language, or behavioral areas. These conditions have onset in the developmental period, may impact daily functioning, and usually last throughout a person's lifetime.

developmental plasticity The concept that development can be modified by particular environmental conditions experienced by a fetus or infant.

diabetes self-management education and support (DSMES) An ongoing process of individualized education and support to facilitate the knowledge, skill, and ability necessary for prediabetes and diabetes self-care and quality of life.

dietary fiber Complex carbohydrates and lignins naturally occurring and found mainly in the plant cell wall. Dietary fiber cannot be broken down by human digestive enzymes.

dietary folate equivalents (DFE) A measure of folate availability used by the Reference Dietary Intakes. 1 DFE = 1 mcg food folate, which is equivalent to 0.6 mcg folic acid.

dietary guidance Providing concise recommendations and consumer information to guide food choices.

dietary guidance system A comprehensive set of dietary and lifestyle recommendations, based on the latest scientific information, that are developed to promote heath and prevent disease or its complications, ensure adequate intake of nutrients of concern, and offer guidance on what and how much to eat.

Dietary Guidelines A report, including scientific information and rationale, on dietary information and guidelines for the general public or a defined subpopulation. The guidelines provide a cohesive set of recommendations that are adopted by the government or organization. They represent policy and are integrated into food, nutrition, and health programs.

dietary pattern The quantities, proportions, variety, or combination of different foods, drinks, and nutrients in diets, and the frequency with which they are habitually consumed.

Dietary Reference Intakes (DRIs) Quantitative estimates of nutrient intakes, used as reference values for assessing the diets of healthy people. DRIs include Recommended Dietary Allowances (RDAs), Adequate Intakes (AI), Tolerable Upper Intake Levels (UL), and Estimated Average Requirements (EAR).

dietary supplements Any product intended to supplement the diet, including vitamin and mineral supplements, proteins, enzymes, amino acids, fish oils, fatty acids, hormones and hormone precursors, and herbs and other plant extracts. In the United States, such products must be labeled "Dietary Supplement."

differentiation Cellular acquisition of one or more characteristics or functions different from that of the original cells.

disproportionately small for gestational age (dSGA) Newborn weight is less than 10th percentile of weight for gestational age; length and head circumference are normal. Also called *asymmetrical SGA*.

diverticulitis Infected "pockets" within the large intestine.

DNA methylation The modification of a replicated strand of DNA by addition of a methyl group (CH_3) to specific regions of the strand. Methylation can suppress the activity of certain genes in ways that affect metabolic processes and disease risk. It is a normal part of development and is needed for cellular differentiation and organ development but can also be influenced by nutritional and other environmental exposures.

doula An individual who surrounds, interacts with, and aids the mother at any time within the period that includes pregnancy, birth, and lactation; may be a relative, friend, or neighbor and is usually but not necessarily female. One who gives psychological encouragement and physical assistance to a new mother.

Down syndrome Also known as trisomy; this is a condition in which three copies of chromosome 21 occur. It can be associated with low muscle tone (hypotonia), short stature, feeding difficulty and risk of overweight.

dumping syndrome A condition characterized by weakness, dizziness, flushing, nausea, and palpitation immediately or shortly after eating and produced by abnormally rapid emptying of the stomach, especially in individuals who have had part of the stomach removed.

dysglycemia An abnormality in blood glucose stability.

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dysgeusia Changes in taste. During pregnancy, changes are thought to be caused by hormonal changes.

dyslipidemia Abnormal blood levels of cholesterol and/or triglycerides resulting from altered lipid metabolism.

early childhood caries (ECC) The presence of one or more decayed (noncavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child 71 months of age or younger.

Early Intervention Program Educational intervention for the development of children from birth up to 3 years of age.

early intervention services Federally mandated evaluation and therapy services for children in the age range from birth to 3 years under the Individuals with Disabilities Education Act.

eating plan A plan for timing of meals and snacks and types and amounts of foods eaten to achieve nutrition goals.

edema Swelling (usually of the legs and feet, but can also extend throughout the body) due to an accumulation of extracellular fluid.

eicosanoids Molecules synthesized from essential fatty acids. They exert complex control over many bodily systems, mainly in inflammation and immunity, and act as messengers in the central nervous system.

embryo The developing organism from conception through 8 weeks.

empty-calorie foods Foods that provide an excess of calories relative to their nutrient content.

endocrine A system of ductless glands, such as the thyroid, adrenal glands, ovaries, and testes, that produces secretions that affect body functions.

endometriosis A disease characterized by the presence of endometrial tissue in abnormal locations, such as deep within the uterine wall, in the ovary, or in other sites within the body. The condition is quite painful and is associated with abnormal menstrual cycles and infertility in 30 to 40 percent of affected women.

endothelium The layer of cells lining the inside of blood vessels.

energy balance An equilibrium state in which the number of calories consumed equals the number of calories expended.

energy-dense foods Foods that have relatively high-calorie values per unit weight of the food.

energy gap The required change in energy expenditure relative to energy intake necessary to restore energy balance.

enrichment The replacement of thiamin, riboflavin, niacin, and iron lost when grains are refined.

enteral feeding Method of delivering nutrients directly to the digestive system, in contrast to methods that bypass the digestive system.

epididymis Tissues on top of the testes that store sperm.

epigenetic (*epi* = over, above) Heritable changes in gene function that do not entail a change in DNA sequence. Epigenetic modifications play a crucial role in the silencing and expression of noncoding portions of genes.

epithelial cells Cells that line the surface of the body.

EPSDT The Early and Periodic Screening, Diagnostic, and Treatment benefit is a part of the Medicaid program and provides coverage for routine well-child visits and dental visits for enrolled children.

ergogenic aids Nutritional products that are purported to enhance performance. Examples range from caffeine and protein powders to sports drinks and energy gels and bars.

essential amino acids Amino acids that cannot be synthesized in adequate amounts by humans and therefore must be obtained from the diet. Also called *indispensible amino acids*.

essential fatty acids Components of fat that are a required part of the diet (i.e., linoleic and alpha-linolenic acids). Both contain unsaturated fatty acids.

essential nutrients Substances required for growth and health that cannot be produced, or produced in sufficient amounts, by the body. They must be obtained from the diet.

estimated energy requirement (EER) The average dietary energy intake for adults in good health, by age, gender, weight, height, and level of physical activity, that is predicted to maintain energy balance and is consistent with good health.

exocytosis The process by which the contents of vacuoles in the cell are carried to the exterior of the cell by fusing the membranes of the vacuole and the cell.

exposure index The average infant milk intake per kilogram body weight per day × (M/P ratio ÷ Rate of drug clearance) × 100. It is indicative of the amount of the drug in the breast milk that the infant ingests and is expressed as a percentage of the therapeutic (or equivalent) dose for the infant.

extremely low-birthweight infant (ELBW) An infant weighing less than 1,000 grams at birth.

familial hyperlipidemia A condition that is hereditary and results in high levels of serum cholesterol and other lipids.

fasting Going 24 hours or more without eating.

fat-free mass Used interchangeably with lean body mass, comprising bone, muscle, water.

fatty acids The fat-soluble components of fats in foods.

fecundity Biological ability to bear children.

fermentable fiber Type of fiber that enters the large colon undigested, where it is acted on by the bacteria of the gut. Formerly called insoluble fiber.

fertility Actual production of children. The word best applies to specific vital statistic rates, but it is commonly taken to mean the ability to bear children.

fetus The developing organism from eight weeks after conception to the moment of birth.

fine-motor skills Development and use of smaller muscle groups demonstrated by stacking objects, scribbling, and copying a circle or square.

fluorosis Permanent white or brownish staining of the enamel of teeth caused by excessive ingestion of fluoride before teeth have erupted.

follicle stimulating hormone (FSH) A hormone produced by the pituitary gland that stimulates ovarian follicle growth and maturation, estrogen secretion, and endometrial changes characteristic of the first portion of the menstrual cycle in women. It stimulates sperm production in men.

food allergy (hypersensitivity) Abnormal or exaggerated immunologic response, usually immunoglobulin E (IgE) mediated, to a specific food protein.

food intolerance An adverse reaction involving digestion or metabolism but not the immune system.

food insecurity Limited or uncertain availability of safe, nutritious foods, or the ability to acquire them in socially acceptable, legal ways.

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food security Access at all times to a sufficient supply of safe, nutritious foods.

fortification The addition of one or more vitamins or minerals to a food product.

free radicals Chemical substances (often oxygen-based) that are missing electrons. The absence of electrons makes the chemical substance reactive and prone to oxidizing nearby molecules by stealing electrons from them. Free radicals can damage lipids, cell membranes, DNA, and tissues by altering their chemical structure and functions. They also form as a normal part of metabolism. Over time, oxidative stress causes damage to lipids, cell membranes, DNA, cells, and tissues.

full-term infants Infants born at or after 37 weeks of gestation.

functional fiber Nondigestible carbohydrates including plant, animal, or commercially produced sources that have beneficial effects in humans.

functional food A food product that has a physiological benefit or reduces the risk of chronic disease beyond basic nutritional functions.

functional hypothalamic amenorrhea (FHA) Defined as a nonorganic (not due to disease) and reversible disorder in the hypothalamus which impairs gonadotropin-releasing hormone (GnRH) pulsatile secretion and suspends ovulation and menstrual cycles.

functional status Ability to perform daily activities to meet basic needs and live independently, including telephoning, grocery shopping, food preparation, and eating.

galacopoiesis Another term for maintenance of lactation following the establishment of lactation

galactogogue A medicine or herbal substance taken with the belief to increase milk supply. It may also be taken to help with breastmilk initiation and maintenance.

galactosemia A rare genetic condition of carbohydrate metabolism in which a blocked or inactive enzyme does not allow breakdown of galactose, causing serious illness in infancy.

gastroesophageal reflux (GER) Movement of the stomach contents upward into the esophagus and may cause spitting up or regurgitation. The condition may require treatment depending on its duration and degree. Most children outgrow GER by 12 to 14 months of age.

gastrostomy Form of enteral nutrition support for delivering nutrition by tube directly into the stomach, bypassing the mouth, through a surgical procedure that creates an opening through the abdominal wall and stomach.

gastrostomy feeding Form of nutrition support for delivering nutrition via a tube placed directly into the stomach. A surgical procedure creates an opening through the abdominal wall and stomach.

gavage feeding A procedure where a tube is passed through the nose or mouth into the stomach. This is used to feed preterm or newborn infants who are not yet able or have weak or uncoordinated ability to suck and swallow.

gene variant An alteration in the normal sequence of a gene. The different forms of the same genes are considered "alleles."

geophagia Compulsive consumption of clay or dirt.

gestational diabetes Carbohydrate intolerance with onset of, or first recognition in, pregnancy.

gingiva Gum tissue.

glucogenic amino acids Amino acids such as alanine and glutamate that can be converted to glucose.

gluten A protein found in wheat, spelt, kamut, dinkel, and triticale (genus Triticum), barley, and rye. Spelt, dinkel, and kamut are ancestral forms of today's wheat. Oats appear on some "gluten" lists; oats are inherently gluten free, but they may be contaminated by gluten-containing grains during processing.

glycemic index A measure of the extent to which blood glucose levels are raised by consumption of an amount of food that contains 50 g of carbohydrate compared to 50 g of glucose. A portion of white bread containing 50 g of carbohydrate is sometimes used for comparison.

glycerol A component of fats that is soluble in water. It is converted to glucose in the body.

glycosylated hemoglobin A1C (HbA1c) A blood test that measures how well the blood sugar level has been maintained over the last 2 to 3 months.

gonadotropin releasing hormone (GnRH) A hormone produced in the hypothalamus that is responsible for the release of follicle stimulating hormone and luteinizing hormone by the pituitary gland.

gravida Number of pregnancies a woman has experienced.

gross-motor skills Development and use of large muscle groups as exhibited by walking alone, running, walking upstairs, riding a tricycle, hopping, and skipping.

growth Increase in an organism's size through cell multiplication (hyperplasia) and enlargement of cell size (hypertrophy).

growth velocity The rate of growth over time.

gut dysbiosis Breakdown in the balance of protective and harmful bacteria and other microbes in the intestines.

health disparity Significant differences in the incidence, prevalence, mortality, and burden of disease and other adverse conditions that exist among specific population groups. Health disparity is closely linked to social and economic disadvantage.

health inequity Significant differences in the incidence, prevalence, mortality, and burden of disease and other adverse conditions that exist among specific population groups that are avoidable, unnecessary and unjust.

healthspan Illness-free life span.

healthy More than the absence of disease, health is a sense of well-being. Even individuals with a chronic condition may properly consider themselves to be healthy. For instance, a person with diabetes mellitus whose blood sugar is under control can be considered healthy.

healthy weight A weight range compatible with normal function and long, healthy life.

heart disease The leading cause of death and a common cause of illness and disability in the United States. Coronary heart disease is the principal form of heart disease and is caused by buildup of cholesterol deposits in the coronary arteries, which feed the heart.

hedonic obesity Body weight maintained above set point due to sustained overeating.

hematocrit An indicator of the proportion of whole blood occupied by red blood cells. A decrease in hematocrit is a late indicator of iron deficiency.

hemoglobin A protein that is the oxygen-carrying component of red blood cells. A decrease in hemoglobin concentration in red blood cells is a late indicator of iron deficiency.

hemoglobin A1c A form of hemoglobin used to identify blood glucose levels over the lifetime of a red blood cell (120 days). Glucose molecules in blood will attach to hemoglobin (and stay attached). The amount of glucose that attaches to

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hemoglobin is proportional to levels of glucose in the blood. The normal range of hemoglobin A1c is 4–5.9 percent. Also called glycosylated hemoglobin and glycated hemoglobin.

HIV Human immunodeficiency virus.

homeostasis Constancy of the internal environment. The balance of fluids, nutrients, gases, temperature, and other conditions needed to ensure ongoing, proper functioning of cells and, therefore, all parts of the body.

homocysteine Another intermediate product that depends on vitamin B_{12} for complete metabolism. However, both vitamin B_{12} and folate (another B vitamin) are coenzymes in the breakdown of certain protein components in this pathway. Thus, elevated homocysteine levels can result from vitamin B_{12}, folate, or pyridoxine deficiencies.

human milk oligosaccharides (HMOs) Medium-length carbohydrates with nutritive and nonnutritive properties

hydrolyzed protein formula Formula that contains enzymatically digested protein, or single amino acids, rather than protein as it naturally occurs in foods.

hyperbilirubinemia Elevated blood levels of bilirubin, a yellow pigment that is a by-product of the breakdown of fetal hemoglobin.

hyperglycemia Abnormally high levels of glucose in the blood.

hyperinsulinemia A state of excess levels of insulin circulating in the blood. It is common among persons with metabolic syndrome and type 2 diabetes and is caused by the pancreas trying to compensate for insulin resistance of cells.

hypertension High blood pressure. It is defined in adults as blood pressure exerted inside blood vessel walls that typically exceeds 140/90 mmHg (millimeters of mercury).

hypertonia Condition characterized by high muscle tone, stiffness, or spasticity.

hypoallergenic Foods or products that have a low risk of promoting food or other allergies.

hypothalamus A section of the brain responsible for the production of many hormones and other chemical substances that affect body functions such as temperature regulation, thirst, hunger, sleep, mood, reproduction, and the release of other hormones within the body.

hypothyroidism A condition characterized by growth impairment, intellectual disabilities, and deafness when caused by inadequate maternal intake of iodine during pregnancy. Used to be called *cretinism*.

hypotonia Condition characterized by low muscle tone, floppiness, or muscle weakness.

immunological Having to do with the immune system and its functions in protecting the body from bacterial, viral, fungal, or other infections and from foreign proteins (i.e., those proteins that differ from proteins normally found in the body).

immunosenescence A progressive decline in immune function, often evidenced by low-grade chronic inflammation.

infant mortality Death that occurs within the first year of life.

infecundity Biological inability to bear children after one year of unprotected intercourse.

infertility Involuntary absence of production of children.

Innocenti Declaration On the Protection, Promotion, and Support of Breastfeeding: Policy statement adopted by participants at the World Health Organization/UNICEF policymakers' meeting on breastfeeding, a global initiative held in Italy in 1990. The policy established exclusive breastfeeding from birth to 4–6 months of age as a global goal for optimal maternal and child health.

insulin Hormone usually produced in the pancreas to regulate movement of glucose from the bloodstream into cells within organs and muscles.

insulin resistance A condition in which cell membranes have a reduced sensitivity to insulin so that more insulin than normal is required to transport a given amount of glucose into cells.

intellectual disability Substantially below-average intelligence and problems in adapting to the environment and the person ability to learn at an expected level and function in daily life which emerge before age 18 years.

intermittent fasting A regimen of reoccurring periods of fasting followed by periods of unrestricted eating.

intra-abdominal fat Fat located within the abdominal cavity around organs such as the liver, pancreas, and intestines. Intra-abdominal fat is referred to as visceral fat and is much more metabolically active than fat stored in other parts of the body.

intrauterine growth restriction (IUGR) Fetal undergrowth from any cause, resulting in a disproportionately low weight, length, or head circumference percentile for gestational age.

iron-deficiency anemia A condition often marked by low hemoglobin level. It is characterized by the signs of iron deficiency plus paleness, exhaustion, and a rapid heart rate.

ischemia Inadequate blood supply to a local area due to partial or complete blockage of a blood vessel.

isotonic Similar salt concentration as the blood.

jejunostomy feeding Another form of nutrition support that delivers nutrition via tube directly into the small intestine.

juvenile rheumatoid arthritis Condition in which joints become enlarged and painful as a result of the dysfunction of the immune system; generally occurs in children or teens.

ketogenic diet High-fat, low-carbohydrate meal plan in which ketones are made from metabolic pathways used in converting fat as a source of energy.

ketones Metabolic by-products of the breakdown of fatty acids in energy formation. β-hydroxybutyric acid, acetoacetic acid, and acetone are the major ketones, or *ketone bodies*.

kwashiorkor A severe form of protein-energy malnutrition in young children. It is characterized by swelling, fatty liver, susceptibility to infection, profound apathy, and poor appetite. The cause of kwashiorkor is unclear.

***L. monocytogenes*, or listeria** A food-borne bacterial infection that can lead to preterm delivery and stillbirth in pregnant women. Listeria infection is commonly associated with the ingestion of soft cheeses, unpasteurized milk, ready-to-eat deli meats, and hot dogs.

La Leche League International, nonprofit, nonsectarian organization dedicated to providing education, information, support, and encouragement to women who want to breastfeed. Founded in 1956 by seven women who had learned about successful breastfeeding while nursing their own babies, it currently has over 5,000 leaders in over 80 countries on every continent except Antarctica. Accredited lay leaders facilitate mother-to-mothers meetings around the world. These meetings moved online due to the coronavirus pandemic to continue to provide breastfeeding support to mothers. (www.lalecheleague.org).

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Glossary

lactation consultant Healthcare professional whose scope of practice is focused on providing education and management to prevent and solve breastfeeding problems and to encourage a social environment that effectively supports the breastfeeding mother–infant dyad. Those who successfully complete the International Board of Lactation Consultant Examiners (IBLCE) certification process are entitled to use the IBCLC (International Board Certified Lactation Consultant) after their names (www.iblee.org).

lactogenesis Another term for human milk production.

lactose A form of sugar or carbohydrate composed of galactose and glucose.

large for gestational age (LGA) Weight for gestational age exceeds the 90th percentile for gestational age. Also defined as birthweight greater than 4,500 g (10 lb) and referred to as *excessively sized for gestational age*, or *macrosomic*.

LDL cholesterol Low-density lipoprotein cholesterol, the lipid most associated with atherosclerotic disease. Diets high in saturated fat, *trans* fatty acids, and dietary cholesterol have been shown to increase LDL cholesterol levels.

lean body mass Sum of fat-free body tissue: muscle, mineral (as in bone), and water.

leptin A protein secreted by fat cells that, by binding to specific receptor sites in the hypothalamus, decreases appetite, increases energy expenditure, and stimulates gonadotropin secretion. Leptin levels are elevated by high, and reduced by low, levels of body fat.

life expectancy Average number of years of life remaining for persons in a population cohort or group; most commonly reported as life expectancy from birth.

life span Maximum number of years someone might live; human life span is projected to range from 110 to 120 years.

liveborn infant A liveborn infant is the outcome of delivery when a completely expelled or extracted fetus breathes, or shows any sign of life, such as beating of the heart, pulsation of the umbilical cord, or definite movement of voluntary muscles, whether or not the cord has been cut or the placenta is still attached.

lobes Rounded structures of the mammary gland.

longevity Length of life, measured in years.

low-birthweight infant (LBW) An infant weighing less than 2,500 grams at birth.

lower esophageal sphincter (LES) The muscle enabling closure of the junction between the esophagus and stomach.

luteal phase The second half of the menstrual cycle (usually days 14–28) that occurs after ovulation.

luteinizing hormone (LH) A hormone produced by the pituitary gland that stimulates ovulation, the development of the corpus luteum (which secretes progesterone), and the production of testosterone in men.

macrobiotic diet This diet falls between semi-vegetarian and vegan diets and includes foods such as brown rice, other grains, vegetables, fish, dried beans, spices, and fruits.

macrophages A white blood cell that acts mainly through phagocytosis.

macrosomia A newborn with an excessive birth weight (macro = big, somia = body). Newborn macrosomia has been defined in several different ways, including birth weight of 4,000–4,500 g (8 lb 13 oz to 9 lb 15 oz) or greater than the 90th percentile of weight for gestational age.

malnutrition The cellular imbalance between the supply of nutrients and energy and the body's demand for them to ensure growth, maintenance, and specific functions.

mammary gland The source of milk for offspring, also commonly called the breast. The presence of mammary glands is a characteristic of mammals.

mammogenesis Another term for mammary growth.

meal replacement A nutritionally balanced beverage, meal bar, or packaged meal used to replace a meal in weight management.

meconium Dark green mucilaginous material in the intestine of the full-term fetus.

medical home The medical home is best described as a model or philosophy of primary care that is patient-centered, comprehensive, team-based, coordinated, accessible, and focused on quality and safety.

medical neglect Failure of parent or caretaker to seek, obtain, and follow through with a complete diagnostic study or medical, dental, or mental health treatment for a health problem, symptom, or condition that, if untreated, could become severe enough to present a danger to the child.

medical nutrition therapy (MNT) Comprehensive nutrition services by registered dietitians to treat the nutritional aspects of acute and chronic diseases.

Medicare Federal health insurance for all people age 65 and older, and for younger individuals with certain disabling conditions.

medicinal herbs Plants used to prevent or remedy illness.

memory impairment Moderate or severe impairment is when four or fewer words can be recalled from a list of 20.

menarche The occurrence of the first menstrual cycle.

meningitis Viral or bacterial infection in the central nervous system, which causes inflammation of the membranes covering the brain and spinal cord that is likely to cause a range of long-term consequences in infancy, such as intellectual disability, blindness, and hearing loss.

menopause Cessation of the menstrual cycle and reproductive capacity in women.

menses The process of menstruation.

menstrual cycle An approximately 4-week interval in which hormones direct a buildup of blood and nutrient stores within the wall of the uterus and ovum maturation and release. If the ovum is fertilized by a sperm, the stored blood and nutrients are used to support the growth of the fertilized ovum. If fertilization does not occur, they are released from the uterine wall over a period of 3 to 7 days. The period of blood flow is called the *menses,* or the menstrual period.

metabolic obesity Body weight set point shifts to a higher level due to alterations of the energy balance system.

metabolic syndrome A constellation of metabolic abnormalities that increase the risk of heart disease, hypertension, type 2 diabetes, and other disorders. Metabolic syndrome is characterized by insulin resistance, abdominal obesity, high blood pressure and triglycerides levels, low levels of HDL cholesterol, and impaired glucose tolerance. It is also called *insulin resistance syndrome*.

metabolism The chemical changes that take place in the body. The conversion of glucose to energy or body fat is an example of a metabolic process.

methylmalonic acid (MMA) An intermediate product that needs vitamin B_{12} as a coenzyme to complete the metabolic

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pathway for fatty-acid metabolism. Vitamin B_{12} is the only coenzyme in this reaction; when it is absent, the blood concentration of MMA rises.

microbiome The totality of microorganisms (bacteria, viruses, bacteriophages, and fungi) along with their collective genetic materials present in or on the human body.

middle childhood Children between the ages of 5 and 10 years; also referred to as "school-age."

mild cognitive impairment (MCI) Subtle loss of memory, thinking, and/or reasoning skills beyond expectations of normal but not serious enough to be classified as dementia.

milk bleb/milk blister A tender inflammatory area sealed off by the epidermis on the nipple that is white or yellow area.

milk/plasma ratio The ratio of the concentration of drug in milk to the concentration of drug in maternal plasma. Since the ratio varies over time, a time-averaged ratio provides more meaningful information than data obtained at a single time point. It is helpful in understanding the mechanisms of drug transfer and should not be viewed as a predictor of risk to the infant, as it is the concentration of the drug in milk, and not the M/P ratio, that is critical to the calculation of infant dose and assessment of risk.

miscarriage Generally defined as the loss of a conceptus in the first 20 weeks of pregnancy. Also called spontaneous abortion.

monounsaturated fats Fats in which only one pair of adjacent carbons in one or more of its fatty acids is linked by a double bond (e.g., –C–C=C–C–).

monovalent ion An atom with an electrical charge of +1 or −1.

morbidity The rate of illnesses in a population.

mortality Rate of death.

myoepithelial cells Specialized cells that line the alveoli and that can contract to cause milk to be secreted into the duct.

necrotizing enterocolitis (NEC) Condition with inflammation or damage to a section of the intestine, with a grading from mild to severe.

neural tube defects (NTDs) A group of birth defects that are caused by incomplete development of the brain, spinal cord, or their protective coverings. Spina bifida is one of the most common types of neural tube defects.

neurobehavioral Pertains to control of behavior by the nervous system.

neuromuscular Term pertaining to the central nervous system's control of muscle coordination and movement.

neuromuscular disorders Conditions of the nervous system characterized by difficulty with voluntary or involuntary control of muscle movement.

neutrophils Class of white blood cells that are involved in the protection against infection.

nonessential amino acids Amino acids that can be readily produced by humans from components of the diet. Also referred to as *dispensable amino acids*.

nonessential nutrients Nutrients required for growth and health that can be produced by the body from other components of the diet.

nonnutritive sucking The sucking by newborns and young infants on items that do not provide fluid or nutrition.

NSF International, a nongovernmental, nonprofit that also tests dietary supplements.

nutrients Chemical substances in foods that are used by the body for growth and health.

nutrient-dense foods Foods that contain relatively high amounts of nutrients compared to their caloric value.

nutraceutical Combination of words *nutrient* and *pharmaceutical* to indicate a food-derived compound that can act as a drug, such as red yeast rice, a statin-like compound.

nutrigenomics The study of diet- and nutrient-related functions and interactions of genes and their effects on health and disease.

nutrition monitoring Assessment of dietary or nutrition status at intermittent times with the aim of detecting changes in the dietary or nutritional status of a population.

nutrition surveillance Continuous assessment of nutritional status for the purpose of detecting changes in trend or distribution in order to initiate corrective measures.

obesogenic diet A pattern of eating and food choices that leads to excessive energy intake and accumulation of body fat.

obesogenic environment The sum of influences that promote overeating and minimize physical activity and lead to weight gain and hinder weight loss.

oral-gastric (OG) feeding A form of enteral nutrition support for delivering nutrition via tube placed from the mouth to the stomach.

osmolality A measure of the concentration of particles in solution.

osteoporosis Condition in which low bone density or weak bone structure leads to an increased risk of bone fracture.

ova Eggs of the woman produced and stored within the ovaries (singular is *ovum*).

oxidative stress A condition that occurs when cells are exposed to more oxidizing molecules (such as free radicals) than to antioxidant molecules that neutralize them. Over time, oxidative stress causes damage to lipids, DNA, cells, and tissues. It increases the risk of heart disease, type 2 diabetes, cancer, and other diseases.

oxytocin A hormone produced during letdown that causes milk to be ejected into the ducts.

pagophagia Compulsive consumption of ice or freezer frost.

parenteral feeding Delivery of nutrients directly into the bloodstream.

parenteral nutrition support Intravenous nutrition or orally modified formulas needed because of inability to consume a regular diet.

parity The number of previous deliveries experienced by a woman; *nulliparous* = no previous deliveries, *primiparous* = one previous delivery, *multiparous* = two or more previous deliveries. Women who have delivered infants are considered to be *parous*.

patient-centered care An approach to care that that considers the individual's medical issues as well as social determinants of health factors, while being respectful of, and responsive to, the patient's preferences, needs, and values and including them in all clinical decisions.

pelvic inflammatory disease (PID) A general term applied to infections of the cervix, uterus, fallopian tubes, or ovaries. Occurs predominantly in women who are less than 30 years of age and is generally caused by infection with a sexually transmitted disease, such as gonorrhea or Chlamydia.

per- and polyfluoroalkyl substances (PFAS) A family of man-made chemicals used in stain resistant fabrics, nonstick cookware, products that resist water, grease, oil, some cosmetics, and water-repellent clothing.

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periconceptional period The time period around conception, variously measured in weeks or months depending on the pregnancy outcomes of interest.

perimenopause and menopause An approximately 4-year period of decreasing estrogen production followed by the end of menstruation; a marking point for increased risk of cardiovascular disease and other chronic conditions for women.

pharmacotherapy Treatment of disease through the use of drugs.

phenylketonuria (PKU) An inherited error in phenylalanine metabolism most commonly caused by a deficiency of phenylalanine hydroxylase, which converts the essential amino acid phenylalanine to the nonessential amino acid tyrosine. Also called hyperphenylalaninemia.

phytochemicals (phyto = plants) Chemical substances in plants, some of which affect body processes in humans that may benefit health. Also called phytonutrients.

pica An eating disorder characterized by the compulsion to eat substances that are not food.

pituitary gland A pea-sized gland located at the base of the brain. It is connected to the hypothalamus and produces and secretes growth hormone, prolactin, oxytocin, follicle-stimulating hormone, luteinizing hormone, and other hormones in response to signals from the hypothalamus.

placenta A disk-shaped organ of nutrient and gas interchange between mother and fetus. At term, the placenta weighs about 15 percent of the weight of the fetus.

placenta abruption The separation of the placenta from its attachment to the uterus wall before the baby is delivered. Also called abruptio placenta. Consequences of this condition range from mild to severe for the mother and fetus depending on blood loss, extent of fetal distress, gestational age of the fetus, and other factors.

polycystic ovary syndrome (PCOS) (polycysts = many cysts; i.e., abnormal sacs with membranous linings). A disorder primarily characterized by androgen excess (particularly testosterone), polycystic ovaries, and ovulatory dysfunction.

polyunsaturated fats Fats in which more than one pair of adjacent carbons in one or more of its fatty acids are linked by two or more double bonds (e.g., –C–C=C–C=C–).

persistent organic pollutants (POPs) A family of chemicals manufactured either for a specific purpose (e.g., pesticides or flame retardants in electrical equipment or furniture) or produced as by-products of incinerated waste. The POP family includes dioxins, polychlorinated biphenyls (PCBs), polybrominated diphenyl ether (PBDE), and organochlorine pesticides.

phenolic compounds A large group of naturally occurring compounds in plant-based foods that contribute sensory qualities to food and heath promoting benefits to the body. Also called polyphenols.

postictal state Time of altered consciousness after a seizure; appears to be like a deep sleep.

postmenstrual age The gestational age plus the chronological age, usually reported in weeks. This is the preferred term during the neonate's time in the hospital. For example, an infant born at 30 weeks who is currently 4 weeks old has a postmenstrual age of 34 weeks.

pouring rights Contracts between schools and soft-drink companies, whereby the schools receive a percentage of the profits of soft-drink sales in exchange for the school offering only that soft-drink company's products on the school campus.

Prader–Willi syndrome Condition in which partial deletion of chromosome 15 interferes with control of appetite, muscle development, and cognition. Most cases of Prader-Willi syndrome occur when a segment of the paternal chromosome 15 is deleted in each cell.

preadolescence The stage of development immediately preceding adolescence; 9–11 years of age for girls and 10–12 years of age for boys.

prebiotics Certain fiberlike forms of indigestible carbohydrates that support the growth of beneficial bacteria in the lower intestine. Nicknamed "intestinal fertilizer."

precision nutrition An approach to developing more targeted and effective diet interventions based on an individual's personal genetic and metabolic characteristics.

prediabetes A condition in which blood glucose levels are higher than normal but not high enough for the diagnosis of diabetes. This intermediate hyperglycemia state is characterized by impaired glucose tolerance, fasting blood glucose levels between 100 and 125 mg/dL, or elevated A1c.

preeclampsia A condition that is typically diagnosed after the 20th week of pregnancy. It is characterized by blood pressure readings that exceed 140/90 mm Hg documented on two occasions by blood pressure measurements made at least four hours apart.

preloads Beverages or food such as yogurt in which the energy/macronutrient content has been varied by the use of various carbohydrate and fat sources. The preload is given before a meal or snack and subsequent intake is monitored. This study design has been employed by Birch and Fisher in their studies of appetite, satiety, and food preferences in young children.

premenstrual dysphoric disorder (PMDD) A severe form of PMS characterized by disabling irritability, sadness, anxiety, depression, and various other symptoms. It begins during the luteal phase of the menstrual cycle and ends with menstrual bleeding.

premenstrual syndrome (*premenstrual* = the period of time preceding menstrual bleeding; *syndrome* = a constellation of symptoms). A condition occurring among women of reproductive age that includes a group of physical and psychological symptoms with onset in the luteal phase and subsiding with menstrual bleeding. Premenstrual dysphoric disorder (PMDD) is a severe form of PMS.

preschool-age children Children between the ages of 3 and 5 years who are not yet attending kindergarten.

preterm infants Infants born before 37 weeks of gestation.

primary malnutrition Malnutrition that results directly from inadequate or excessive dietary intake of energy or nutrients.

primordial prevention Actions to prevent development of a disease risk factor through very early intervention including pregnancy, infancy, childhood, and young adulthood.

probiotics Strains of lactobacillus and bifidobacteria that have beneficial effects on the body. Also called "friendly bacteria."

prolactin A hormone necessary for milk production.

proportionately small for gestational age (pSGA) Newborn weight, length, and head circumference are less than 10th percentile for gestational age. Also called *symmetrical SGA*.

prostacyclins Biologically active substances produced by blood vessel walls that inhibit platelet aggregation (and therefore blood clotting), dilate blood vessels, and reduce blood pressure.

prostaglandins A group of physiologically active substances derived from the essential fatty acids. They are present in many tissues and perform such functions as the constriction or dilation of blood vessels

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and stimulation of smooth muscles and the uterus.

psychostimulant Classification of medication that acts on the brain to improve mental or emotional behavior.

puberty The period in life during which humans become biologically capable of reproduction.

pulmonary Related to the lungs and their movement of air for exchange of carbon dioxide and oxygen.

quality of life A measure of life satisfaction that is difficult to define, especially in an aging heterogeneous population. Quality-of-life measures include factors such as social contacts, economic security, and functional status.

Recommended Dietary Allowances (RDAs) The average daily dietary intake levels sufficient to meet the nutrient requirements of nearly all (97–98 percent) healthy individuals in a population group. RDAs serve as goals for individuals.

recumbent length Measurement of length while the child is lying down. Recumbent length is used to measure toddlers less than 24 months of age and those between 24 and 36 months who are unable to stand unassisted.

reflex An automatic (unlearned) response that is triggered by a specific stimulus.

registered dietitian nutritionist (RDN) An individual who has acquired food and nutrition knowledge and skills necessary to pass a national registration examination and who participates in continuing professional education.

resilience Ability to bounce back, to deal with stress, and recover from injury or illness.

resting energy expenditure The amount of energy needed by the body in a state of rest.

resting energy expenditure (REE) Measured or estimated energy expenditure in an individual at rest.

Rett syndrome Condition in which a genetic change on the X chromosome results in severe neurological delays, causing children to be short, thin-appearing, and unable to talk.

rooting reflex an involuntary action that occurs when the infant's mouth or check is stroked resulting in the infant's head turning toward the stimulus and opening his or her mouth.

sandwich generation Refers to middle-aged adults, usually women, who are multigenerational caregivers dealing with the complex roles of wife, mother, daughter, caregiver, and employee.

sarcopenia Age-associated loss of skeletal muscle mass and function.

sarcopenic obesity Low lean body mass combined with excessive fat stores.

saturated fats Fats in which adjacent carbons in the fatty acid component are linked by single bonds only (e.g., –C–C–C–C–).

scoliosis Condition in which the vertebral bones in the back show a side-to-side curve, resulting in a shorter stature than expected if the back were straight.

secondary condition Common consequence of a condition, which may or may not be preventable over time.

secondary malnutrition Malnutrition that results from a condition (e.g., disease, surgical procedure, medication use) rather than primarily from dietary intake.

secondary sexual characteristics Physiological changes that signal puberty, including enlargement of the testes, penis, and breasts and the development of pubic and facial hair.

secretory cells Cells in the acinus (milk gland) that are responsible for secreting milk components into the ducts.

secretory immunoglobin A (sIgA) A protein found in secretions that protect the body's mucosal surfaces from infections. The mode of action may be by reducing the binding of a microorganism with cells lining the digestive tract. It is present in human colostrum but not transferred across the placenta.

seizures Condition in which electrical nerve transmission in the brain is disrupted, resulting in periods of loss of function that vary in severity.

semen The penile ejaculate containing a mixture of sperm and secretions from the testes, prostate, and other glands. It is rich in zinc, fructose, and other nutrients. Also called seminal fluid.

senescence The condition or process of deterioration with age.

Sertoli cells Cells in the testes that secrete substances that nourish and support the maturation of immature sperm cells.

serum iron, plasma ferritin, and transferrin saturation Measures of iron status obtained from blood plasma or serum samples.

sex hormone binding globulin (SHBG) A protein that binds with the sex hormones testosterone and estrogen. These hormones are inactive when bound to SHBG, but are available for use when needed. Low levels of SHBG are related to increased availability of testosterone and estrogen in the body.

shoulder dystocia Blockage or difficulty of delivery due to obstruction of the birth canal by the infant's shoulders.

small for gestational age Newborn weight is less than 10th percentile for gestational age. Also called *small for date (SFD)*.

social determinants of health Socioeconomic and environmental factors that are powerful determinants of health and are largely outside of the control of individuals and groups, but affect a wide range of health, functioning, and quality of life outcomes.

spastic quadriplegia A form of cerebral palsy in which brain damage interferes with voluntary muscle control in both arms and legs.

spinal muscular atrophy (SMA) Condition in which muscle control declines over time as a result of nerve loss, causing death in childhood.

stature Standing height.

steroid hormones Hormones such as progesterone, estrogen, and testosterone produced primarily from cholesterol.

stroke An event that occurs when a blood vessel in the brain ruptures or becomes blocked. Stroke is often associated with "hardening of the arteries" in the brain. Also called cerebral vascular accident.

subfertility Reduced level of fertility characterized by unusually long time to conception (over 12 months) or repeated pregnancy losses.

suckle A reflexive movement of the tongue moving forward and backward; earliest feeding skill.

supercentenarian Person who has reached age 110 or more, validated.

***T. gondii*, or toxoplasmosis** A parasitic infection that can impair fetal brain development. The source of the infection is often hands contaminated with soil or the contents of a cat litter box; or raw or partially cooked pork, lamb, or venison.

T-lymphocyte A white blood cell that is active in fighting infection. (May also be called T-cell; the T in T-cell stands for thymus.) These cells coordinate the immune system by secreting hormones that act on other cells.

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telomere A caplike structure that protects the ends of chromosomes; it erodes during replication.

telopeptides Molecules that degrade the major collagen of tendon and bone and leave carbon and nitrogen fragments in blood and urine.

teratogenic Exposures that produce malformations in embryos or fetuses.

testes Male reproductive glands located in the scrotum. Also called testicles.

therapeutic lifestyle change A higher-intensity intervention approach with focus on sustained behavior changes to reduce risk and slow disease progression among high-risk individuals. Often includes individual, group, and virtual components delivered through clinic or community organizations over a period of months.

thermic effect of food (TEF) Energy required for the digestion, absorption, and metabolism of food; approximately 10 percent of energy needs.

thrombus Blood clot.

time-restricted eating A dietary approach that consolidates all calorie intake to 6- to 12-hour periods during the active phase of the day, without necessarily altering diet quality and quantity.

toddlers Children between the ages of 1 and 3 years.

thromboxanes Biologically active substances produced in platelets that increase platelet aggregation (and therefore promote blood clotting), constrict blood vessels, and increase blood pressure.

Tolerable Upper Intake Levels Highest level of daily nutrient intake that is likely to pose no risk of adverse health effects to almost all individuals in the general population; gives levels of intake that may result in adverse effects if exceeded on a regular basis.

total diet approach Guidance based on overall eating patterns that meet needs with a variety of foods over time.

total fiber Sum of dietary fiber and functional fiber.

***trans* fat** A type of unsaturated fat present in hydrogenated oils, margarine, shortenings, pastries, and some cooking oils that increase the risk of heart disease. Fats containing fatty acids in the *trans* versus the more common *cis* form are generally referred to as *trans* fat.

***trans* fatty acids** Fatty acids that have unusual shapes resulting from the hydrogenation of polyunsaturated fatty acids. *Trans* fatty acids also occur naturally in small amounts in foods such as dairy products and beef.

transcytosis Transport of macromolecules across the interior of a cell. Macromolecules are captured in a sac from mother's serum drawn across the cell, and released into the milk ducts.

transient ischemic attacks (TIAs) Temporary and insufficient blood supply to the brain.

type 1 diabetes A disease characterized by high blood glucose levels resulting from destruction of the insulin-producing cells of the pancreas. This type of diabetes was called juvenile-onset diabetes and insulin-dependent diabetes in the past, and its official name is type 1 diabetes mellitus.

type 2 diabetes A disease characterized by high blood glucose levels due to the body's inability to use insulin normally, to produce enough insulin, or both.

unsaturated fats Fats in which adjacent carbons in one or more fatty acids are linked by one or more double bonds (e.g., –C–C=C–C=C–).

USP (United States Pharmacopeia) A nongovernmental, nonprofit organization (since 1820); establishes and maintains standards of identity, strength, quality, purity, processing, and labeling for healthcare products.

vegan diet The most restrictive of vegetarian diets, allowing only plant foods.

very low-birthweight infant (VLBW) An infant weighing less than 1,500 grams at birth.

viscous fiber Types of fiber characterized by their ability to form a gel solution when combined with liquid. Formerly called soluble fiber.

weaning Gradual process of switching an infant's diet from breast milk and formula to other foods and fluids.

work of breathing (WOB) A common term used to express extra respiratory effort in a variety of pulmonary conditions.

xerostomia Dry mouth can be a side effect of medications (especially antidepressants), of head and neck cancer treatments, of diabetes, and also a symptom of Sjögren's syndrome, which is an autoimmune disorder for which no cure is known.

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Dietary Reference Intakes (DRI)

Estimated Energy Requirements (EER), Recommended Dietary Allowances (RDA), and Adequate Intakes (AI) for Water, Energy, and the Energy Nutrients

Age (yr)	Reference BMI (kg/m^2)	Reference Height cm (in)	Reference Weight kg (lb)	Water[a] AI (L/day)	Energy EER[b] (kcal/day)	Carbohydrate RDA (g/day)	Total Fiber AI (g/day)	Total Fat AI (g/day)	Linoleic Acid AI (g/day)	Linolenic Acid[c] AI (g/day)	Protein RDA (g/day)[d]	Protein RDA (g/kg/day)
Males												
0–0.5	–	62 (24)	6 (13)	0.7[e]	528	60	–	31	4.4	0.5	9.1	1.52
0.5–1	–	71 (28)	9 (20)	0.8[f]	704	95	–	30	4.6	0.5	11	1.20
1–3[g]	–	86 (34)	12 (27)	1.3	1,015	130	19	–	7	0.7	13	1.05
4–8[g]	15.3	115 (45)	20 (44)	1.7	1,513	130	25	–	10	0.9	19	0.95
9–13	17.2	144 (57)	36 (79)	2.4	2,211	130	31	–	12	1.2	34	0.95
14–18	20.5	174 (68)	61 (134)	3.3	3,142	130	38	–	16	1.6	52	0.85
19–30	22.5	177 (70)	70 (154)	3.7	3,067[h]	130	38	–	17	1.6	56	0.80
31–50	22.5[i]	177 (70)[i]	70 (154)[i]	3.7	3,067[h]	130	38	–	17	1.6	56	0.80
>50	22.5[i]	177 (70)[i]	70 (154)[i]	3.7	3,067[h]	130	30	–	14	1.6	56	0.80
Females												
0–0.5	–	62 (24)	6 (13)	0.7[e]	494	60	–	31	4.4	0.5	9.1	1.52
0.5–1	–	71 (28)	9 (20)	0.8[f]	686	95	–	30	4.6	0.5	11	1.20
1–3[g]	–	86 (34)	12 (27)	1.3	984	130	19	–	7	0.7	13	1.05
4–8[g]	15.3	115 (45)	20 (44)	1.7	1,407	130	25	–	10	0.9	19	0.95
9–13	17.4	144 (57)	37 (81)	2.1	1,962	130	26	–	10	1.0	34	0.95
14–18	20.4	163 (64)	54 (119)	2.3	2,374	130	26	–	11	1.1	46	0.85
19–30	21.5	163 (64)	57 (126)	2.7	2,368[j]	130	25	–	12	1.1	46	0.80
31–50	21.5[i]	163 (64)[i]	57 (126)[i]	2.7	2,368[j]	130	25	–	12	1.1	46	0.80
>50	21.5[i]	163 (64)[i]	57 (126)[i]	2.7	2,368[j]	130	21	–	11	1.1	46	0.80
Pregnancy												
1st trimester				3.0	+0	175	28	–	13	1.4	46	0.80
2nd trimester				3.0	+200[k]	175	28	–	13	1.4	71	1.10
3rd trimester				3.0	+200[k]	175	28	–	13	1.4	71	1.10
Lactation												
1st 6 months				3.8	+400	210	29	–	13	1.3	71	1.30
2nd 6 months				3.8	+380	210	29	–	13	1.3	71	1.30

Note: For all nutrients, values for infants are AI. Dashes indicate that values have not been determined.

[a]The water AI includes drinking water, water in beverages, and water in foods; in general, drinking water and other beverages contribute about 70 to 80 percent, and foods, the remainder.
Conversion factors: 1 L = 33.8 fluid oz; 1 L = 1.06 qt; 1 cup = 8 fluid oz.

[b]The Estimated Energy Requirement (EER) represents the average dietary energy intake that will maintain energy balance in a healthy person of a given gender, age, weight, height, and physical activity level. The values listed are based on an "active" person at the reference height and weight and at the midpoint ages for each group until age 19.

[c]The linolenic acid referred to in this table and text is the omega-3 fatty acid known as alpha-linolenic acid.

[d]The values listed are based on reference body weights.

[e]Assumed to be from human milk.

[f]Assumed to be from human milk and complementary foods and beverages. This includes approximately 0.6 L (~2½ cups) as total fluid including formula, juices, and drinking water.

[g]For energy, the age groups for young children are 0–2.99 months, 3–5.99 months, 6 months – 2.99 years, 3–13.99 years.

[h]For males, subtract 10 kcalories per day for each year of age above 19.

[i]Because weight need not change as adults age if activity is maintained, reference weights for adults 19 through 30 years are applied to all adult age groups.

[j]For females, subtract 7 kcalories per day for each year of age above 19.

[k]Energy deposition for normal weight. For underweight +300 kcal, overweight +150kcal. obese −50 kcal.

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Tolerable Upper Intake Levels (UL) for Minerals

Age (yr)	Sodium (mg/day)	Chloride (mg/day)	Calcium (mg/day)	Phosphorus (mg/day)	Magnesium (mg/day)[d]	Iron (mg/day)	Zinc (mg/day)	Iodine (µg/day)	Selenium (µg/day)	Copper (µg/day)	Manganese (mg/day)	Fluoride (mg/day)	Molybdenum (µg/day)	Boron (mg/day)	Nickel (mg/day)	Vanadium (mg/day)
Infants																
0–0.5	–	–	1,000	–	–	40	4	–	45	–	–	0.7	–	–	–	–
0.5–1	–	–	1,500	–	–	40	5	–	60	–	–	0.9	–	–	–	–
Children																
1–3	1,500	2,300	2,500	3,000	65	40	7	200	90	1,000	2	1.3	300	3	0.2	–
4–8	1,900	2,900	2,500	3,000	110	40	12	300	150	3,000	3	2.2	600	6	0.3	–
9–13	2,200	3,400	3,000	4,000	350	40	23	600	280	5,000	6	10	1,100	11	0.6	–
Adolescents																
14–18	2,300	3,600	3,000	4,000	350	45	34	900	400	8,000	9	10	1,700	17	1.0	–
Adults																
19–50	2,300	3,600	2,500	4,000	350	45	40	1,100	400	10,000	11	10	2,000	20	1.0	1.8
51–70	2,300	3,600	2,000	4,000	350	45	40	1,100	400	10,000	11	10	2,000	20	1.0	1.8
>70	2,300	3,600	2,000	3,000	350	45	40	1,100	400	10,000	11	10	2,000	20	1.0	1.8
Pregnancy																
≤18	2,300	3,600	3,000	3,500	350	45	34	900	400	8,000	9	10	1,700	17	1.0	–
19–50	2,300	3,600	2,500	3,500	350	45	40	1,100	400	10,000	11	10	2,000	20	1.0	–
Lactation																
≤18	2,300	3,600	3,000	4,000	350	45	34	900	400	8,000	9	10	1,700	17	1.0	–
19–50	2,300	3,600	2,500	4,000	350	45	40	1,100	400	10,000	11	10	2,000	20	1.0	–

[d]The UL for magnesium applies to synthetic forms obtained from supplements or drugs only. Note: An upper Limit was not established for vitamins and minerals not listed and for those age groups listed with a dash (—) because of a lack of data, not because these nutrients are safe to consume at any level of intake. All nutrients can have adverse effects when intakes are excessive.

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