Prevalence and determinants of schistosomiasis among pre-school-aged children (PSAC) along the west banks of the Lilongwe River, Malawi from March 2025 to June 2025

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ABSTRACT

Background: Schistosomiasis remains a most significant public health problem in Malawi, particularly in communities living near freshwater. Pre-school-aged children (PSAC) are increasingly recognized as a vulnerable group due to frequent water exposure, yet are excluded from surveillance and treatment programmes, resulting in limited understanding of their disease burden and key risk factors in Malawi. Emergent evidence suggests that infection can occur early in life which contributes to hostile health outcomes, yet in Malawi prevalence, intensity, and key determinants data remain limited. This study aims to address these gaps; providing insights into the epidemiology of schistosomiasis among pre-school-aged children and informing inclusive public health interventions.

Methods: A cross-sectional study was conducted between March and June 2025 in communities located along the west banks of the Lilongwe River in Lilongwe District, Malawi. A total of 309 pre-school-aged children aged 1–5 years were designated using a probability-based sampling approach. Data on socio-demographic characteristics, environmental exposure, and behavioural risk factors were collected using structured caregiver questionnaires. Urine and stool samples were examined for *Schistosoma haematobium* and *Schistosoma mansoni* using urine filtration and Kato–Katz techniques, respectively. Descriptive statistics and logistic regression analysis were performed to determine prevalence and associated risk factors.

Results: Among the 309 children who provided complete samples, 157 (51.0%) were infected with at least one Schistosoma species. Infection with *S. haematobium* was detected in 110 children (36.0%), while *S. mansoni* infection was detected in 73 children (24.0%). Co-infection occurred in 26 children (8.4%). Prevalence increased with age, with older children demonstrating higher infection rates. Most households (99.3%) were located within one kilometer of the river and 91.9% of children had direct contact with river water. In multivariable logistic regression analysis, a history of previous schistosomiasis-related illness was associated with lower odds of current infection **(Adjusted OR = 0.50; 95% CI: 0.28–0.92).**

Conclusion: Schistosomiasis is highly prevalent among PSAC living along the west banks of Lilongwe River, indicating intense devastating early-life exposure. The high prevalence observed in this study, untreated PSAC may act as a persistent reservoir of infection, undermining national

schistosomiasis control and elimination efforts. The exclusion of PSAC from routine MDA programmes in Malawi represents a critical programmatic gap. The findings highlight the urgent need to include PSAC in schistosomiasis surveillance and MDA programmes, alongside strengthened water, sanitation, and hygiene (WASH) interventions, to support Malawi's schistosomiasis elimination goals.

Keywords: *Schistosomiasis; pre-school-aged children; prevalence; determinants; Lilongwe River; Malawi.*

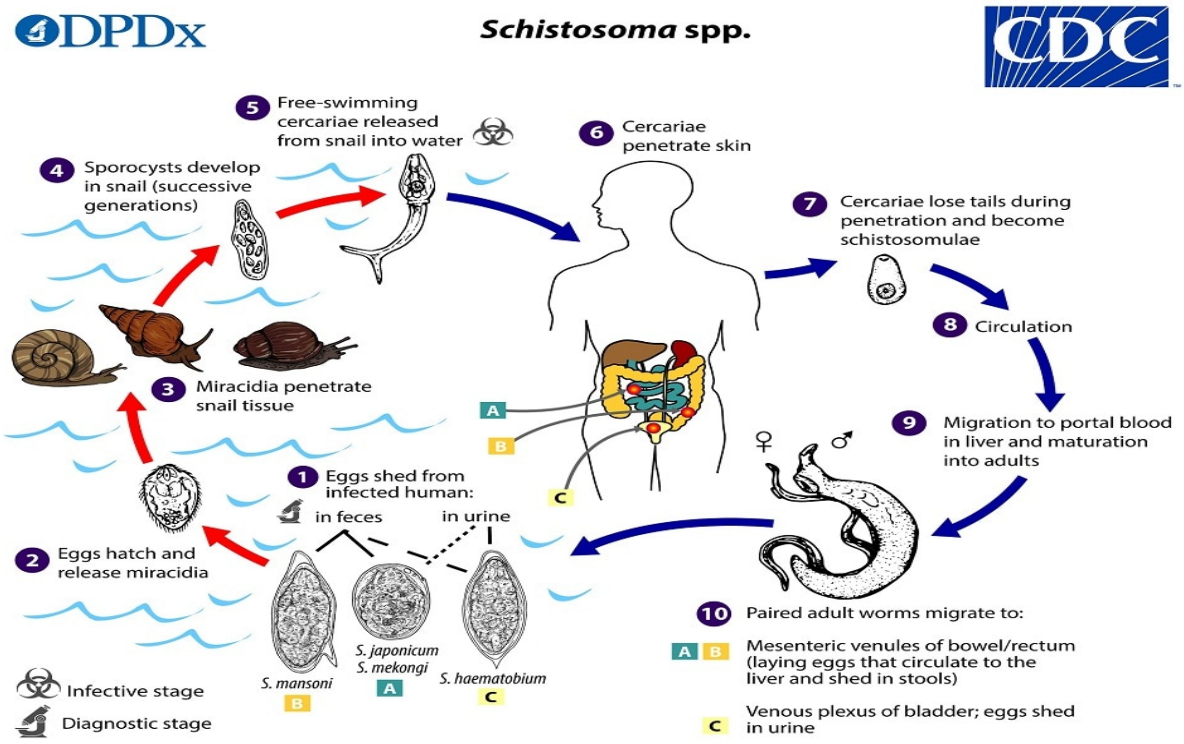
1.0. INTRODUCTION

Schistosomiasis is caused by trematode worms of the genus Schistosoma and remains most prevalent neglected tropical diseases globally[i]. An estimated 250 million people are infected globally, and over 90% of infections occur in sub-Saharan Africa, where poverty, limited sanitation, and exposure to contaminated freshwater sustain transmission[ii]

Chronic infection contributes significantly to morbidity, particularly among children[iii]. Documented complications include anemia, malnutrition, impaired growth, reduced cognitive development, and long-term organ damage[iv]. Transmission occurs when humans come into contact with freshwater contaminated with cercariae released by infected freshwater snails, which serve as intermediate hosts of the parasite[v]. Sub-Saharan Africa is home to 95% of the 250 million people estimated to be infected with schistosomiasis[vi]. In the region, schistosomiasis affects the poorest communities characterized by insufficient supply of clean water and poor access to adequate sanitation[vii] In 2012, the WHO set out a roadmap for eliminating schistosomiasis as a public health problem by 2025[viii]. In 2020, WHO published a new road map to guide action against NTDs during the decade 2021–2030. (WHO, 2020). The two major species infecting humans in sub-Saharan Africa are *Schistosoma haematobium*, which causes urogenital schistosomiasis and *S. mansoni*, the cause of intestinal schistosomiasis. *S. Intercalatum* and *S. guineensis* also cause intestinal schistosomiasis but are less prevalent. Schistosomiasis is more rampant in poor rural communities especially places where fishing and agricultural activities are dominant. Domestic activities such as washing clothes and fetching water in infected water expose women and children to infection. Recreational activities like swimming and poor hygiene also make children vulnerable to schistosomiasis (WHO,2014). Human infection occurs through contact with water contaminated with freely swimming, short-lived Schistosome larvae, known as cercariae, which are shed by infected snails. Specifically, cercariae infect exposed humans through skin penetration. Within human hosts, they develop into sexually mature Schistosomes. Depending on their species, the resting place of adult parasites is in the blood vessels around the bladder or the intestine of the infected human host. Schistosomes mate and produce eggs that are excreted through urine or faeces. After reaching freshwater, eggs hatch into so-called miracidia, a second short-lived larval form of the parasite that can infect species-specific snail hosts and undergo asexual replication. Infected snails complete the parasite's life cycle by shedding cercariae into water (Colley et al., 2014). The

transmission of schistosomiasis is thus controlled by contact with environmental freshwater infested with parasite larvae.

1.0.1. Life Cycle of Schistosomiasis



In Africa, *Schistosoma haematobium* and *Schistosoma mansoni* are the predominant species, responsible for urogenital and intestinal schistosomiasis, respectively[ix]. Children are disproportionately affected due to age-specific behavioral and environmental exposure patterns, such as swimming, bathing, and playing in contaminated water[x]. Schistosomiasis control efforts have focused primarily on school-aged children (SAC), who are considered to carry the highest intensity of infection and morbidity[xi].

However, accumulating evidence over the past two decades has demonstrated that pre-school-aged children (PSAC) are also exposed to schistosomiasis early in life and can harbor significant infections and associated morbidity[xii]. It is estimated that more than 50 million PSAC worldwide are infected with schistosomiasis, although the true burden is likely underestimated due to limited surveillance and diagnostic challenges in this age group[xiii]. Studies from several endemic African countries, including Uganda, Tanzania, and Nigeria, have reported substantial prevalence of both *S. haematobium* and *S. mansoni* among PSAC, along with early signs of anemia, growth retardation, and organ pathology[xiv].

In Malawi, schistosomiasis remains a major public health concern, with national prevalence estimates ranging between 50% and 60% in some endemic areas[xv]. Transmission is sustained by extensive freshwater systems, including Lake Malawi and major river networks such as the Shire and Lilongwe rivers. Communities residing along riverbanks experience heightened exposure due to heavy reliance on surface water for domestic use, subsistence farming, fishing, and recreation[xvi]. Previous studies conducted in lakeshore and riverine districts have documented high schistosomiasis prevalence among children, including PSAC, highlighting ongoing transmission and early exposure[xvii]. A landmark study in Chikhwawa District, Malawi demonstrated that PSAC have a significant and previously under-recognized burden of both urogenital and intestinal schistosomiases[xviii]. The study also showed co-infection between species *(S. haematobium and S. mansoni).* A study done in Malengachanzi, Nkhotakota stated that PSAC are actively involved in transmission and should be included in treatment programs[xix]. The Blantyre study in 2009, provides supporting environmental evidence that Schistosomiasis infection in Malawi begins in early childhood, and PSAC are an important but neglected risk group[xx].

Despite growing evidence of schistosomiasis burden among PSAC, national control programmes in Malawi rely largely on school-based mass drug administration (MDA) targeting SAC. The exclusion of PSAC from routine preventive chemotherapy has been attributed to historical policy gaps, safety concerns regarding praziquantel use in young children, and the delayed availability of paediatric formulations[xxi]. As a result, PSAC may remain untreated and act as a persistent reservoir of infection, potentially undermining schistosomiasis control and elimination efforts[xxii]. The west banks of the Lilongwe River represent a high-risk ecological and social setting characterized by frequent human–water contact, limited access to safe water and sanitation, and sustained transmission potential. However, recent epidemiological data on schistosomiasis prevalence and associated determinants among PSAC in this area is scarce. Generating localized evidence is essential for informing targeted interventions, strengthening surveillance systems, and supporting Malawi's National Schistosomiasis Control Programme in alignment with the World Health Organization (WHO) 2030 NTD Roadmap.[xxiii] Therefore, this study aimed to determine the prevalence and determinants of schistosomiasis among pre-school-aged children living along the west banks of the Lilongwe River in Lilongwe District, Malawi

1.0.2. Risk Factors Contributing to Schistosoma Transmission in PSAC

In Schistosome-endemic areas, a significant amount of the exposure to infection in PSAC is passive (i.e., use of contaminated water in the home or children being bathed/sitting in a dish of fresh water while the guardian conducts domestic chores), particularly in the youngest children[xxiv] (Derick N. et al,2018). Exposure becomes more active as the children grow (e.g., accompanying caregivers to water sources for domestic chores) (Garba A et al, 2010, Odogwu SE, et al 2006). Therefore, in the early years of infants and young children, exposure to infection is closely linked to that behavior of the caregiver. This disassociates as children grow older, become independent, and frequently visit contaminated water sources with friends and/or older siblings. Globally, risk factors are well documented and include poor sanitation, frequent contact with contaminated water, and lack of health education**.** Evidence from a global meta-analysis pointing out that environmental and behavioral determinants significantly contribute to transmission (Steinmann Pet al 2006). This observation was further supported by a meta-analysis where they noted the disease's strong correlation with poor water access and hygiene practices (Mc Manus et al,2018). In sub-Saharan Africa, risk factors such as playing, bathing, and washing in infested water bodies are well established (Gryseels B et al,2006). A study in Nigeria reported exposure to contaminated water bodies as a risk factor to schistosomiasis (Ekpo UF et al, 2013). Similar findings have been reported in a meta-analysis where exposure to contaminated water bodies was reported to have an association with the risk of schistosomiasis, Zimbabwe, Côte d'Ivoire and Ethiopia (Mohammed T et al, 2024). In Ethiopia, contact with an open water while playing, bathing or urinating was an increase the risk of acquiring infection with the parasite in this population group, (Tigist Mohammed et al,2025). Schistosoma haematobium infection and associated risk factors among pre-school age children in Gambella, Ethiopia. (Parasite Epidemiol Control, 2025). In Angola, laundry in the river was a common risk factor (Sánchez-Marqués et al, 2023). There are no published reports of schistosomiasis among PSAC on Madagascar meaning their plight is currently overlooked.




The Parent with her two children fetching water from Lake Malawi.The other child is put in the basin of fresh water waiting to be bathed.

In South Africa reported not using soap for hand washing being a risk factor for schistosomiasis. (Sacolo-Gwebu H et al, 2019). In Burkina Faso, proximity to the pond was a risk factor, (Cisse M et al,2021). In Zimbabwe the risk of schistosomiasis was more prevalent in children whose caregivers used river water for bathing and whose caregiver was infected, (Mutsaka -Makuvaza MJ et al,2019). It has been demonstrated that for this age group, the distance from the water point and the history of visiting the water points were significant factors for schistosomiasis infection Cisse M et al,2021). This is particularly important as river or lake water, which is the source of water for bathing and other domestic uses including drinking for some of the villagers, was continuously contaminated with *S. Mansoni* eggs from the poor sanitation practice of defecating in the water. This corroborates studies carried out in Western Kenya and Tanzania which found that the prevalence of infection decreases with the increase of the distance from the lake water shore. (Deodatus M. Ruganuza et al,2015). In Malawi, a study in Chikhwawa found water contact as a risk factor while a study in Nkhotakota reported that *S. haematobium* to be associated with age related to water contact. Analysis established that having a parent in rice farming, bathing and Washing from the river, fishing occupation is a key risk factors for schistosomiasis. It was also surprising to note that those schoolchildren who received Praziquantel during MDA had significantly higher prevalence, (Poole H et al,2014).

1.0.3. Prevalence of Schistosomiasis in PSAC

In 2018, it was estimated that Schistosomiasis affect at least 290.8 million people, claiming 24,068 lives globally (WHO,2022). Globally, WHO estimates 50 million PSAC are infected with Schistosomiasis, (WHO,2020). It is highly debilitating, leading to an estimated loss of 1.43 million all-age disability-adjusted life years (Leslie et al,2022).50-70% of PSAC are infected of

Schistosomiasis in Sub-Saharan Africa, (WHO,2022). Studies from Southern Africa sites report low to Moderate average PSAC prevalence, (HD Mazigo et al,2021).

In Ethiopia on PSAC revealed that, 25 % of the participants were affected by intestinal schistosomiasis, emphasizing the significant burden of the disease in this vulnerable group (Kemal et al., 2019). In Ethiopia, the overall prevalence of S. haematobium infection (microscope positive) was 16.7 %, with 20 % heavy intensity of infection, (Tigist Mohammed,2025). This study in Ethiopia showed that S. haematobium infection is prevalent among PSAC in Gambella region, (Tigist Mohammed et al,2025). Schistosomiasis is widely spread in many African countries including Sudan, Kenya, Ethiopia, Malawi, Zambia, and Madagascar. (Oyime, P, et al,2021). A global systematic review indicated that prevalence of *S. haematobium* in endemic countries ranges from 5% to over 60%**,** with variations due to geography, age, and socio-economic conditions and it is highest in Sub-Saharan Africa**.** (Collaboration GB of DP et al,2013). Approximately 120 million individuals in sub-Saharan Africa have schistosomiasis-related symptoms while about 20 million undergo hardship as a result of chronic presentations of the disease (Chitsulo L et al,2000). A similar study found that while North African countries showed reduced prevalence due to effective national control programs, whilst sub-Saharan Africa remained heavily burdened (Gryseels B et al,2006)**.** Steinmann and co-workers documented that over 200 million individuals from Africa, Asia, and South America are infected with this disease (Steinmann et al,2006). The WHO further estimated that Schistosome infections accounts for over 40% of the world tropical disease burden with the exclusion of malaria (Olveda et al, 2013).

A study in Nigeria found a very high prevalence of *S. haematobium* of 58.1% among PSAC, previously thought to be at low risk (Ekpo UF et al,2010). In Uganda, a study was conducted in two lake side's where prevalence varied from SAC and PSAC. (Stothard JR et al,2013). Lake Albert had a high prevalence of *S. haematobium* of 59.3% while Lake Victoria recorded a prevalence of 43.2%. for *S. mansoni*, lake Albert reported 44.5% prevalence while Lake Victoria reported 13.2%. A national survey in Uganda, (Exum NG et al,2019). found a prevalence of 36.1% among PSAC moderately lower compared to Malawi possibly due to water-related practices and limited coverage of control programs. Contrary to that, a study in South Africa found significantly low prevalence of *S. haematobium* [1.0%] and *S. mansoni* [0.9%] possibly due to good control measures (Sacolo-Gwebu H et al,2022). Tanzania rural has reported 44.4% prevalence of *S. mansoni* using KATO-KATZ (Ruganuza DM et al,2015). Contrary to that, a

study in urban Tanzania found slightly lower prevalence of schistosomiasis of 15.8% (Said K et al,2017). Recent evidence indicates that pre-school children (PSAC) living in *S. mansoni* highly endemic areas are at similar risk of schistosomiasis infection and morbidity as their school aged siblings (Ruganuza DM et al,2015)**.** The high prevalence of schistosomiasis was attributed to inadequate water supply in the districts, poor sanitation, and a low level of socioeconomic development in most parts of Mozambique, (G. Augusto et al,2019). Agricultural, domestic, occupational and recreational tasks may foster contact with potentially infested water, and thus represent risk factors even in places where water provisioning and sanitation are adequate. Also, differences in behavior and lifestyle represent major potential determinants of transmission heterogeneity (Funk et al., 2015).

In Zambia, schistosomiasis is prevalent and endemic across all 10 provinces with *S. haematobium* endemic in 69 districts and *S. mansoni* in 49 districts. The increase in the prevalence may be attributed to climate change, changes in livelihood strategies religious and cultural practices which may influence human-water contact behaviors (e.g. baptism by immersion), and health-seeking behaviors and potentially perpetuate the maintenance of the parasite within the population, (Tembo et al,2022). The current study also indicates that the burden of morbidities associated with schistosomiasis in Zambia has not been fully explored, (Chester et al,2018). The schistosomiasis infection may present long-term health threats to the populations (Chester et al,2018). The infection affects people of all ages, however, children bear a huge burden. Efforts to control the disease have focused on mass treatment of school-aged children, with praziquantel (PZQ) advocated for schools where the prevalence of the disease is higher in School-age children (aged 5–14 years) in endemic areas such as Zambia have been the primary target of preventive chemotherapy interventions but like any other sub-Saharan African Country, the lack of a suitable pediatric praziquantel formulation has excluded preschool children from mass drug administration efforts (Sakubita,P et al,2020).

Higher prevalence of schistosomiasis in children, preschool-aged children (PSAC), i.e., those aged ≤5 years, for a long time were considered to be at a low risk of infection and even if infected, the impact on their health was unknown or considered negligible (Derick N et al,2018). Infection prevalence data from a number of epidemiological studies have led to the estimation that at least 50 million PSAC in Africa are infected with schistosomiasis, but the true global infection and disease burden remains to be quantified (Mutapi F et al). This makes it difficult to make operational and economic plans for controlling schistosomiasis in PSAC.

Despite Malawi government introducing mass drug administration in schools as a measure of controlling the infection, the prevalence rate of the infection in children is still high. Studies conducted across various regions of Malawi have highlighted the endemic nature of schistosomiasis in the country. In Malawi, Preschool children have been overlooked despite emerging evidence from other countries and other parts of Malawi that preschoolers carry significant levels of schistosomiasis infection and are at risk of infection just like their older school-aged counterparts. (World Health Organization,2011).

In Malawi, a study reported a prevalence of 49.5 % among PSAC in Chikhwawa district (Poole H et al,2014).Studies in selected communities in Malawi's estimated prevalence rates are up to 94.9% for S.heamatobium and up to 67.0% for S. mansoni with considerable geographical variation (Ruganuza et al,2015**).** Many of the areas where schistosomiasis in preschool children abounds are often characterized by impoverished or under-resourced local static health systems**.** (Stothard JR et al, 2013).Lake shore surveys in Malawi, show 23.7% chldren are affected by Schistosomiasis (mostly school-aged chlrdren) illustrating higher transimission rate along lakeshore areas, of which PSAC in these communities have substatial exposure too,(Kayuni et al,2017).

1.0.3. Determinants of Schistoma infection

PSAC schistosomiasis is driven by direct freshwater contact(bathing, playing, caregiver water use), household/socioeconomic and WASH factors, local ecology (snail habitats, seasonality, and caregiver knowledge/ behavior, and programmatic gaps (Excluding PSAC in MDA due to limited drug formulations, (Kalinda C, et al,2020).Globally, Infants and toddlers are exposed when caregivers bathe them or when they play in Lakes/ streams water, even short contacts can transmit the infection, (UF EKPO et al,2012). Lack of Safe household water and sanitation increases like hood of using infested water for domestic tasks and child bathing. (RE Donohue et al,2017). Caregiver knowledge and practices on where/ how they bathe children, whether they void known risky sites, strongly affect PSAC exposure (Sacolo-Gwebu H et al,2019). Schistosomiasis is highly focal; presence of infected snail habitats near households strongly raises risk for PSAC who are taken to those sites, (S Summers et al, 2022). Historically PSAC were excluded from SAC MDA leading to a treatment gap and persistent infection reservoir, (C. Kalinda et al,2020).

In Many Sub-Saharan settings, PSAC prevalence is non-negligible where households are close to infested water. (Age-mobility, siblings, and caretaker) routines influence the exposure. (C. Kalinda,2020). Lower wealth index(poverty)is repeatedly associated with higher infection risk (less access to piped water, longer reliance on open water). (RE Donohue, et al 2017). Maternal infection status and caregivers' education predict child infection in several SSA studies (when mothers are infected, they more frequently use infested water or pass exposure risk to children. (Helen Poole et al,2017). Studies in South Africa and neighboring areas find caregivers water-contact practices (fishing, bathing and washing), lack of safe water, and care giver education as major predictors for PSAC infection (H. Sacolo-Gwebu,2019). Caregiver KAP studies in SAA link limited knowledge to higher child exposure. (Raquel SM et al,2023).Multiple Malawi studies show PSC infections and that caregiver factors (knowledge, water use) and proximity to water contact sites predict PSAC infections and that caregiver factors (knowledge, water use) and proximity to water contact sites predict PSAC infection. Some studies recommend including PSAC and Mothers in National control programs. (Helen Poole et al,2014). A study in Malengachanzi/ Nkhotakota associated caregiver knowledge and visiting water contact sites with child schistosomiasis infection, (V.B. Moyo et al, 2016).

1.0.4. Challenges in Diagnosis and Treatment.

Currently, the available diagnostic methods for schistosomiasis are those that rely on stool and urine microscopy for parasite detection. These include Kato-Katz (KK) and urine microscopy, serum antibodies, antigen detection, and the detection of DNA of the parasite. Common diagnostic tools (Kato-Katz [KK] stool smear for *S. Mansoni*, Urine filtration/ dipstick for *S. Haematobium*) are less sensitive in young children (PSAC) due to lower infection intensities (WHO,2022). In a study from Homa Bay County, Kenya, the Kato-Katz test had a sensitivity of only 57.6% in PSAC Vs 73.2% for Point –Of-Care Circulating Cathodic Antigen test (POC-CCA) when using combined gold standard (KK+POC-CCA). Diagnosis plays a critical role in measuring the impact of interventions as it determines levels of reduction of disease, infections, and parasite transmission (WHO,2022). The sensitive, affordable, and accurate diagnostics are necessary to monitor, treat, and perform continuous surveillance of schistosomiasis cases, (Yohana C et al,2023, WHO, 2022, Minzi et al,2022). Efforts have been made to develop new diagnostic tools for schistosomiasis, but sensitivity, specificity, and affordability remain the major challenges for Sub-Saharan Africa. (Yohana et al,2023, WHO. Diagnostic target product

2021, Mkungwe et al 2023). Regardless of the causative agents, schistosomiasis treatment is based on using a single drug (Praziquantel), at least to date, (Yohana C et al,2023, WHO,2022, Kokaliaris C et, al,2023). Researchers have been able to come up with multiplex-based PCR assay but the need for DNA extraction, cold chains, and sophisticated machines such as thermocyclers are the major challenges to its use, especially in developing countries and remote settings areas, where the disease affects the most. CCA and CAA (Circulating Anodic Antigen) have been investigated as genus-specific biomarkers to detect Schistosomes, and POC diagnostics based on the 2 antigens are available, (Perella M, et al,2018). The POC-CCA test, which is commercially available, can accurately demonstrate moderate to heavy S. mansoni infection, and some studies have indicated that it cannot be used in low infection settings, (Straily A et al, 2022). The debate about the low sensitivity of microscopy has existed for several decades, and the WHO recommends much more sensitive approaches to diagnose schistosomiasis in low-transmission settings (WHO. Diagnostic target product profiles,2022). Although (Nucleic Acid Amplification Tests) NAATs, POC-CCA, and antibody tests are reported to offer much better sensitivity than microscopy, despite being expensive for most of Sub- Saharan Countries, studies have indicated a potential risk for these assays to designate negative for some positive samples, which might significantly affect the actual prevalence estimates and elimination strategies, particularly where Schistosoma infection burden is low (Yohana C et al ,2023, Meurs L et al,2022, Fereke et al 2022). According to the WHO, the overall performance of Schistosoma infection diagnosing tools remains moderate, with most tools having low to moderate sensitivity or specificity, (Yohana C,2023). Protein-based biomarkers (CCA, CAA, and antibodies) are also ubiquitous targets for Schistosoma infection, with POC-CCA being WHO recommended for surveillance of S. mansoni (Yohana C, et al2023). Few studies have also reported that antibody-based tests offer much better sensitivity than microscopy (Hoekstra PT et al,2021, Hoeman J,et al,2022). Still, their specificity is much more reduced in communities where Schistosoma infection is co-infected with other related helminths or the availability of the circulating antibodies in some successfully treated individuals (WHO Diagnstics,2021). For instance, Hoermann and colleagues reported the Schistosoma ICT IgG-IgM rapid diagnostic test have 100% sensitivity in detecting single or multiple Schistosomes, and the test indicated 100% specificity in serum from healthy individuals, while samples with helminths related to Schistosomes lowered specificity to 85%. (Hoerman et el,2022). In 2021, the WHO highlighted that most countries health ministry’s lack effective tools

for monitoring and evaluating schistosomiasis control programs, (WHO Diagnostic,2021). In the same report, WHO pointed out that the current gold standard approach limits the frequency of monitoring schistosomiasis due to the need for trained personnel, a microscope, and sometimes stool samples, which are only sometimes friendly to health worker practitioners. Therefore, WHO developed diagnostic Target Product Profile (TPPs) to guide the development of new diagnostics to detect schistosomiasis prevalence reliably (, (WHO Diagnostic,2021). According to the WHO, the new TPPs aims to improve the specificity and sensitivity of the existing diagnostic methods and seeks to enable the detection of non-stool or venous blood samples such as saliva, finger stick blood, or urine. The diagnostic TPPs considered existing challenges to meeting all REASSURED criteria, and therefore, the combination of 2 in vitro tests was proposed to assess the monitoring and evaluation of schistosomiasis control programs and determine whether transmission has been interrupted reliably in the community (Moetlhoa B et al, 2023, Land KJ, et al,2019). In this case, both tests might be point-of-care based, or one screening point-of-care, and the confirmatory test, which might be laboratory based and much more expensive.

Schistosomiasis control has focused on treating school-aged children (>6 years) and adults through mass drug administration (MDA). Following the recent development of a paediatric praziquantel (PZQ) formulation for children aged <5 years, there are now concerted efforts to determine optimal and effective ways to integrate treatment of these children into national schistosomiasis control programmes.

1.0.5. **Control Strategies and WHO Road Map on Schistosomiasis**

WHO’s NTD Road map 2021-2030 sets global targets to reduce morbidity and to move toward elimination of schistosomiasis as a Public-Health problem by 2030, and explicitly promotes extending interventions beyond school-aged children to include other at-risk groups such as PSAC. Within the World Health Organization 2012–2020 roadmap for control and elimination of schistosomiasis, the scale-up of mass drug administration with praziquantel is set to change the epidemiological landscape across Africa. (WHO,2020). The roadmap adopted by the World Health Organization (WHO) for eliminating neglected tropical diseases aims to eliminate schistosomiasis, as a public health concern, by 2030, (Ombeni Ally et al,2022).WHO’s updated schistosomiasis guidance (2022) emphasizes more inclusive preventive chemotherapy(PC) strategies, improved diagnostics, surveillance, and integration with water, sanitation and hygiene (WASH) and snail control and supports treating infected PSAC and including them in large-scale

treatment when paediatric formulation are available.(Wami WM, et al,2022). While progress has been made towards reducing schistosomiasis morbidity control in several sub-Saharan African countries, there is still more that needs to be done, (WHO,2022). Proper surveillance using accurate diagnostics with acceptable sensitivity and specificity is essential for evaluating the success of all efforts against schistosomiasis in PSAC, (Ombeni Ally, et al,2022). Many efforts have been made to eliminate schistosomiasis as one of the major public health concerns , and in 2022, the WHO updated guidelines for controlling and eliminating human schistosomiasis(WHO,2021).The WHO recommends an integrated approach, combining the extension of preventive chemotherapy to all people at risk from 2 years of age in communities with a 10% prevalence reduction, sanitation, Praziquantel treatment in health facilities, and snail control to eliminate schistosomiasis (WHO,2023). Effective and sustained paediatric schistosomiasis treatment is an important target of the 2030 World Health Organization (WHO) neglected tropical diseases (NTDs) roadmap. Trials show Praziquantel is effective and generally safe in PSAC at appropriate doses (orodispersible pediatric formulation). (M N'diaye,2021). The road map targets the elimination of schistosomiasis as a public health problem by 2030 and the interruption of Schistosoma transmission in humans in selected countries by 2030. The main strategy employed is the large-scale MDA of praziquantel for annual preventive chemotherapy in all age groups from 2 years old not just school children. On the global stage, MDA remains the cornerstone of schistosomiasis control. WHO recommends annual praziquantel treatment in endemic areas. (WHO,2020). Maximum impact of Schistosome treatment programmes will be realized through effective treatment of PSAC (Derick N et al, 2018). Attainment of these targets will contribute to progress towards Sustainable Development Goal 3; there is a need to ensure healthy lives and promote well-being for all at all ages. The WHO strategy to control and eliminate human schistosomiasis includes preventive chemotherapy of at-risk groups, access to improved drinking water, improved sanitation, hygiene education, environmental management, and snail control achieve this target. The PSAC population will need to be included in National Schistosomiasis treatment programs globally. A multi-country study in East Africa examined the effectiveness of national MDA campaigns in countries such as Uganda, Mali, and Tanzania. (McManus DP et al 2018). While the study found significant reductions in infection prevalence post-MDA, it also noted disparities in program implementation and community participation. In contrast, a systematic review in Senegal questioned the long-term sustainability of these programs without community-led sanitation and health education (Danso-Appiah et al,2002).

A study in Cameroon, evaluated integrated control strategies in suggesting that combining MDA with behavior change interventions led to a more pronounced decline in prevalence (Danso Appiah et al,2002). However, a study conducted in Kenya argue that even with integrated strategies, persistent transmission hotspots remain, indicating the need for localized, adaptive interventions. (King CH et al,2006) A global meta-analysis echoed these findings, revealing that sustained control efforts are needed beyond mass drug administration [MDA] to address the socio-ecological context of transmission. Similarly, another global meta-analysis emphasized the complexity of Schistosome biology and the need for integrative control approaches that include improved sanitation and snail control (Colley et al,2014).

1.0.6. SH control in Malawi

Malawi carries an MDA that currently targets school-aged children (aged 6–14 years) annually with high coverage rates. However, MDA has not been shown to lead to the elimination of infection due to poor community awareness, involvement in identifying the pertinent risk factors for the infection and exclusion of the PSAC group population (Makaula P et al,2022). The WHO advocates for the use of an integrated approach including Water, Sanitation, and Hygiene (WASH) strategies, snail control, and behavioral change interventions to achieve the elimination of schistosomiasis, (WHO,2022. The provision of safe water and adequate hygiene has been proven an expedient tool for decreasing the incidence of schistosomiasis and other water-borne diseases. However, in most African countries, including Malawi, access to WASH services largely remains a challenge. It can also be controlled by targeting vector snails and avoiding contact with contaminated water (Makaula et al,2018, Generally, the prevalence and factors associated with schistosomiasis vary from region to region. This calls for localized evidence in order to come up with strategies and interventions that are specific to a particular area.

1.0.7. Knowledge Gaps in PSAC

Limited knowledge among community members regarding schistosomiasis transmission, symptoms, and preventive measures is another important aspect to consider. Many endemic countries lack age-disaggregated surveillance for children <5yrs, (DNM Osakunor,2018). There is lack of reliable, low-cost clinical/biomarker indicators of early schistosomiasis morbidity in PSAC e.g anaemia, growth/cognitive impacts, urinary markers (WM.Wami et al,2015). This hampers programmatic decision-making. In most Sub-Saharan African Countries, granular maps that identify micro-hotspots for PSAC exposure are unavailable, this limits approaches. (Kalinda

et al,2020). In Tanzania according to 2024-2025 prevalence survey on PSAC indicates that national data for PSAc is still patchy. (A. Michael, UNDP,2025). Systemic reviews in Zambia highlights gaps in fine-scale mapping and ecology data relevant to PSAC exposure pathways. (C. Kalinda et al,2018). MDA interventions are started but not up to scale or are irregular in countries like Angola, Botswana, Central African Republic, Chad, Congo, Gabon, Guinea-Bissau, Nigeria, South Sudan, and Zambia. While the countries are at different levels of maturing their programmes, operational research is needed in these countries to inform scale up and to optimize treatment coverage. (Mwinzi et al,2025)

1.0.8. Consequences of Schistosomiasis in PSAC.

Globally, PSAC were excluded from MDA programs, but research shows they suffer real morbidity even at early age, (Osakunor et al,2018). The early disease usually improves with treatment. Main consequences documented globally include, anemia, malnutrition, cognitive and developmental deficits Hematuria, albuminuria, Hepatosplenic changes in endemic areas and Stunted growth, (Colley et al,2014, Mutapi et al,2011). Hepatosplenic schistosomiasis carries a relatively good prognosis because hepatic function is preserved until the end of the disease (unless variceal bleeding occurs)**,** (Professor F.E.G. Cox, 2005). End-stage complications of Schistosomiasis are genital schistosomiasis, Bladder cancer, and severe pulmonary hypertension (Professor F.E.G. Cox, 2005). Growth impairment and Cognitive development has been reported in most countries in Sub-Saharan Africa. Zimbabwean PSAC with *S. haematobium* showed higher stunting growth and malnutrition rates, (Mutapi,F,et al.(2011). Three months of first infection, heamaturia appeared in PSAC and older children, cleared only after treatment (Mutapi,F,et al.(2011). Zimbabwe an infected PSAC scored lower in domains like learning, communication, and motor skills of which some gained after praziquantel, (Rujen,N, et al,2012). Schistosomiasis increased odds of URTI (Upper Respiratory Tract Infection), Malaria, dermatophytosis as co-infections worsens severely in PSAC, (Sousa-Figueiredo,JC.,et al,2012). Studies in Kwazulu-Natal found even prevalence PSAC infections associated with early urinary morbidity such as hematuria. (Mazigo,H.D, et al, 2018). Most extensively studies in Zimbabwe showed a strong link between PSAC schistosomiasis and Malnutrition, growth stunting, anemia and development delays. (Midzi,N et al,2017, Nduluza et al,2017). Studies in Chikwawa district in Malawi, showed 17.7% of PSAC had active *S. Haematobium* of which25% of infected PSAC had hematuria and albuminuria, whilst 49.5% of PSAC had schistosomiasis antibodies/antigens

exposure and early immune activation, (Poole, H et al,2014). A study in Nkhotakota,13% PSAC had egg-patent urinary schistosomiasis, and the infected PSAC had heamaturia and dysuria indicating symptomatic morbidity, (Moyo et al,2016). In Lake shore areas, studies revealed that higher school children in the communities has anemia, and are growth stunting, (Kayuni et al, 2017).



11-year-old boy with ascites and portal hypertension due to consequences of chronic schistosomiasis (Agusan del Sur, Philippines, 2005).

Had this child had treatment at a preschool age this might have been averted, which is perhaps a strong indictment that further inaction is unethical. This has shown that young children can have heavy infections even at an age as young as 3 years old, (Midzi,N et al,2017, Nduluza et al,2017).. It has been depicted that the heavier the infection the more severe the morbidity; however, even light egg patent infections. **(Deodatus et al, 2015).** Gaps relating to infection, disease dynamics, and treatment need must be addressed if we are to deliver sustainable Schistosome infection and disease control in PSAC and strengthen schistosomiasis elimination programmes ((Derick N et al,2018). The health impact of schistosomiasis in PSAC includes poor growth and cognition in affected children

1.0.9. Gap Analysis

In Malawi, the gaps were identified in awareness levels, indicating the need for targeted health education and awareness campaigns. Schistosomiasis can be controlled using approaches that include improved sanitation, health education, and treatment using available and safe drugs to be given to all age groups. This is more appropriate because, in addition to living in an endemic country, lack of hygiene and recreational habits for Preschool-aged children and school-age children such as swimming and playing near infested water bodies increases the population's vulnerability to infection. Furthermore, exposure to infested waters for adults during income-

generating activities like fishing sustains the transmission cycle of the infection (Malawi Demographic Health Survey,2020). Some studies show PSAC infection and links with maternal infection, but larger cohorts examining growth/ cognitive outcomes and programmatic pilots area limited. (H.poole, et al, 2014.

1.0.10. **Treatment Gap**: PSAC are not targeted to receive Praziquantel within current preventive chemotherapy campaigns, resulting in a significant treatment gap where infected children might wait up to 6 years before receiving first treatment in school. At this period, they would have suffered a lot of consequences.

1.0.11. **Limited gaps**: Due to limited resources, the researcher did not reach out to PSAC in all the regions in Malawi.

1.0.12. **Knowledge Gaps**: Limited understanding of schistosomiasis burden, risk factors, and health impact among PSAC in the community.

2.0. Methodology

2.1. Study design and setting.

This cross-sectional study design survey was conducted in 35 villages with similar socio-economic, agricultural and cultural activities from 19th March, 2025 to 24th June, 2025. The study assessed the prevalence and determinants of schistosomiasis in PSAC in communities along West banks of Lilongwe River from Likuni to Malili traditional Authority Headquarters in Lilongwe district, Malawi. The study was conducted in the West Banks of Lilongwe river in Lilongwe District. The main occupation for the residents is mainly subsistence farming and fishing for populations living along water bodies. The Lilongwe River saves as their main water source for daily activities such as gardening, drinking, cooking, fishing and bathing or swimming. The communities have three primary schools and four functional boreholes. People can access a paying healthcare facility by walking for a few hours. There was no evidence that the schools provide health education for the prevention of schistosomiasis as most care givers who went through same schools had limited knowledge on schistosomiasis infection and prevention

Fig 2: Map showing area of study



2.2. Study Population

According to the 2018 Census, Lilongwe West has a population of 115,931 (Malawi National statistics, 2018). For this study, 309 participants were randomly selected from 400 residents living in communities along the west banks of the Lilongwe River in Lilongwe District to ensure a representative sample of the target population

2.3. Eligibility, Inclusion, and Exclusion Criteria

Pre-school-aged children between 1- 5 years old residing in the communities along the West banks of Lilongwe River were randomly selected. Parents of PSAC who showed interest in participating in the study and provided informed consent were included. Children who were too ill to participate or who had a severe medical condition that would interfere with participation in the study. Children who had received treatment for schistosomiasis within the past six months and Individuals who did not provide consent for the children to participate and all children above the eligible age were excluded.

2.4. Sampling and Sample size determination

The sample for the study consisted of a population of 309 children of ages from 1yr to 5 years. Thirty-five villages were purposively selected to be included in the study due to their geographical location, water usage and being close to the river course. We used the proportional to size formula for the cross-sectional survey to estimate the sample size as follows: The Total population of Lilongwe is 1,637,500 by 2018.

Formula: $n= Z^2 \times p \times [1-P] / d^2$

Where

n= required Sample

Z=Z-score [confidence level] 95% [1.96]

P= estimated prevalence of schistosomiasis in the population [since prevalence is unknown]

d= desired margin of error [precision]

Calculations

Estimated prevalence [p] = 0.3 [30%].

Desired Margin of error [d] = 0.05 [5%].

Confidence level=95% [Z=1.96]

$n = 1.96^2 \times 0.3 \times [1- 0.3] / 0.05^2$

n = 3.8416 x 0.3 x 0.7 / 0.0025.

nâ= 0.773315 / 0.0025

n= 309.326

=309

The eligible children's guardians were requested for assent and parental consent. All caregivers for 309 PSAC consented to participate in the study hence there was no exclusion from the study. The response rate for the study was however notably 100% high and was limited to designed sample size.

To minimize bias, a cluster sampling with probability proportional to Size [PPS] method was used to select **N** of PSAC in the communities along Lilongwe river bank. The villages were randomly selected into clusters using PPS where the probability of selecting a cluster is proportional to its population size. Within each selected cluster, randomly sample PSAC aged 1-5 years using a systematic sampling technique e.g. every 5^{th} household was employed and the PSAC population was clearly defined i.e. age 1-5 years in this case. In each selected village, the number of PSAC was obtained from the mothers or caregivers to determine the number required from each household. The selection of children at each village was done through systematic random sampling using households which have children aged from 1 year to 5 years who fall in PSAC caregivers and only 309 respondents participated in the study.

Thirty-five villages located along the Lilongwe River were selected based on proximity to the river and similar socio-economic characteristics. Cluster sampling with probability proportional

to size was used to allocate the sample across villages. Within each village, households with eligible children were identified and systematic random sampling was used to select households. When more than one eligible child was present in a household, one child was selected using simple random sampling.

2.5. Survey questionnaire development and validation

A structured questionnaire was developed using the Theoretical Rational Approach [TRA], where targeted constructs of knowledge and awareness of schistosomiasis were assessed. The questionnaire construction not only followed the Protection Motivation Theory [PMT], but also the Knowledge Attitude and Practice [KAP] Theory. The questionnaire had 39 dichotomous items of which 10 subjected to the demographic data, 15 questions measures on knowledge of signs and symptoms of schistosomiasis, key risky behaviors, and type of domestic water, either bore hole or river water, 5 items asked for the knowledge of previous treatment of praziquantel and Albendazole and 9 questions items based on knowledge sanitation and prevention of schistosomiasis. The binary scale comprised of “yes, or no, frequent or not frequent were used in all the items except a few which had nominal scale measurements.

2.6. Data collection

Data was collected using a structured, interviewer-administered questionnaire completed by caregivers. The questionnaire captured socio-demographic characteristics, distance to river site, river water usage, water contact behaviors, sanitation and hygiene practices, and previous history of schistosomiasis-related illness. The questionnaire was developed in English, translated into Chichewa, and pretested in a non-study community.

2.7. Sample Collection

Each enrolled child provided one urine and one stool sample. Urine samples were collected between 10:00 hours and 14:00 hours and examined for *Schistosoma haematobium* eggs using the standard urine filtration technique. 5–7 g of Stool was collected. Consequently, 10% formaldehyde was added to the stool sample as preservative, whereas no preservative material was added to the urine samples. All samples were then transferred to the laboratory, parasitology Department for analysis. Both samples were kept in the fridge at temperature -45 to -50 degrees Celsius as wait for analysis.

2.8. Microscopic Parasitological Laboratory examination

Stool samples were processed using the Kato–Katz thick smear technique to detect *Schistosoma mansoni* eggs. All laboratory procedures followed standard parasitological protocols, and quality control was ensured through duplicate slide reading by trained laboratory technicians. All the study participants submitted both urine and stool samples in a dry, clean well-labelled plastic container. Approximately 5–10 ml of urine and
Urine samples were microscopically examined for the presence of *S. haematobium* eggs by using Kato-Katz filtration method. The number of eggs were calculated from a microscopic field. The microscopic diagnosis of *S. mansoni* infection in faecal samples was performed using Kato-Katz stool examination method. All microscopic slides containing the eggs of *S. haematobium* or *S. mansoni* were considered positive, whereas the absence of the eggs was recorded as negative. **Examination of specimen started as soon as the samples reached the laboratory.** The remaining samples were stored in the fridge to avoid eggs hatching if present in the stool and urine.

2.9. Data management and statistical analysis

2.9.1. Data Management

Completed questionnaires were checked in the field for completeness and consistency before data entry. Laboratory results from diagnostic tests-urine filtration microscopy, urine reagents strip and stool Kato-Katz were linked to corresponding data using unique identification codes. All data were double-entered in excel for cleaning, and then exported to STATA 15.0 for analysis. Data cleaning involved range and consistency checks, and implausible values were verified against original records. Categorical variables were coded as binary or nominal categories, while continuous variables such as age and distance to water body were categorized appropriately to facilitate interpretation.

2.9.2. Statistical analysis

Descriptive statistics were used to summarize the characteristics of the study population. Continuous variables such as age and distance to water source were presented as means with standard deviations or medians with interquartile ranges, depending on distribution. Categorical variables such as sex, type of water source and presence of latrine were summarized as frequencies and percentages. The Primary outcome was the prevalence of schistosomiasis infection among PSAC, expressed as the proportion of children who tested

positive on any diagnostic test. The secondary outcome was the intensity of infection categorized as light, moderate, or heavy i.e. depending on the number of eggs found according to WHO guidelines (Add citation).

Bivariate analysis was performed to assess association between independent variable and schistosomiasis infection. Pearson's chi-square test was used for categorical variables, while student t-test was used for continuous variables, depending on normality. Variables with a p-variable <0.2 in bivariate analysis were considered for inclusion in Multivariable models. Multivariable logistic regression analysis was conducted to identify independent determinants of schistosomiasis infection. Odds Ratio with 95% confidence intervals were reported. For the secondary outcome (infection intensity), ordinal logistic regression was used. A p-value of 0.05 was considered statistically significant.

3.0. Results

3.1. Participant Characteristics

A total of 309 pre-school-aged children (PSAC) were enrolled in the study, of whom 308 provided complete biological samples for laboratory analysis. Most participants were aged ≥2 years (78.3%), while (21.7%) were younger than two years. 59.2% were Male children, while 40.8% were female. Nearly all households 99.4% were located within one kilometer of the Lilongwe River. A large proportion of children (91.9%) had direct contact with river water through bathing, playing, or accompanying caregivers during domestic activities. The majority of households (85.1%), relied on river water for domestic use while about 6 in every 10 of the households had good sanitation (63.8%, n = 197), about 2 in every 10 households equally had better sanitation and hygiene (19.7%, n = 61) and poor sanitation and hygiene (16.5%, n = 51). In terms of level of parental education, majority of parents had attained primary education (78.3%, n = 242), only very few (2.3%, n = 7) had attained secondary level and 19.4% (n = 60) had not attended any formal education.9.4). When asked whether participant had previous illness prior to the study, almost 1 in every 4 indicated they had previous illness. In terms of their sanitation and hygiene knowledge of schistosomiasis infection, most of them indicated they had knowledge (78.6%, ***n* = 243**). In terms of their water contact with cattle, majority of them indicated they had contact (94.5%, ***n* = 292**).

A high proportion of children (91.9%) had documented direct contact with river water. Most caregivers reported using river water for bathing children and other domestic activities. Limited

access to improved sanitation facilities was common across households, further increasing exposure risk.

Table 2: Characteristics of Participants

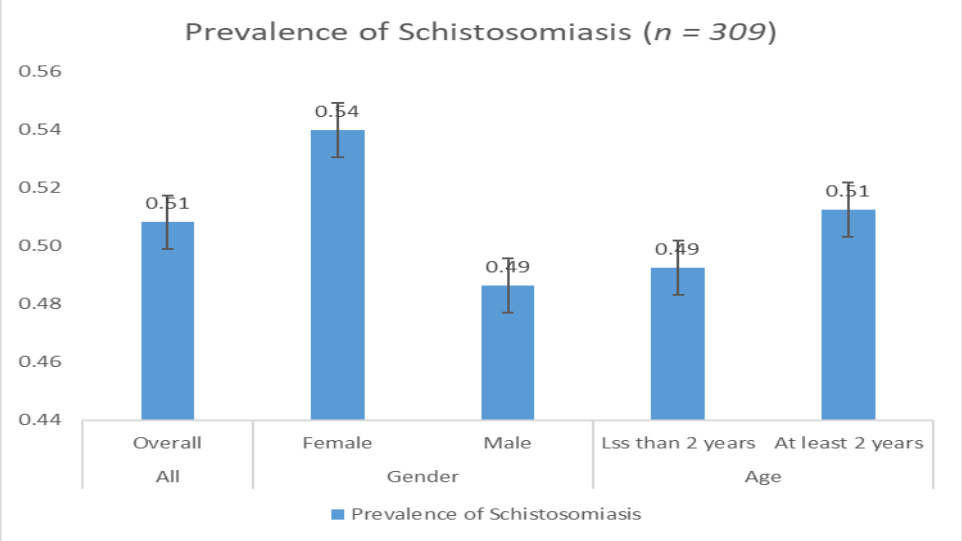
Characteristic	Category	N(%)
Age	<2 years	67(21.7)
	>=2 years	242(78.3)
Gender	F	126(40.8)
	M	183(59.2)
Household proximity to river	Less than one kilometer	307(99.4)
	At least one Kilometer	2(0.7)
Contact with water sources	No	25(8.1)
	Yes	283(91.9)
Frequency of river water contact	Less Frequent	157(50.8)
	More frequent	152(49.2)
Water quality for home use	Borehole	46(14.9)
	River water	263(85.1)
Sanitation and hygiene	Poor	51(16.5)
	Better	61(19.7)
	Good	197(63.8)
Level of parental education	None	60(19.4)
	Primary School	242(78.3)
	Secondary School	7(2.3)
Previous illness prior to the study	No	234(75.7)
	Yes	75(24.3)
Received Albendazole prior to the study	No	298(96.4)

	Yes	11(3.6)
Sanitation and hygiene knowledge	No	66(21.4)
	Yes	243(78.6)
In contact with cattle water	No	17(5.5)
	Yes	292(94.5)
Prevention services received	No	150(48.5)
	Yes	159(51.5)

3.2. Prevalence of schistosomiasis

Overall, 157 of the 308 children tested positive for schistosomiasis, giving an overall prevalence of 51.0% (95% CI: 45.1–56.5). *S. haematobium* infection was detected in 36.0% of participants; while *S. mansoni* infection was detected in 24.0%; Co-infection with both species occurred in 8.4%. Prevalence was slightly higher among female children (54%) compared to males (49%). and increased with age, with older children demonstrating higher infection rates.

Figure 1: Prevalence of Schistosomiasis among Pre- school Aged children, disaggregated by Gender and Age group



By age, prevalence was slightly higher among the older children 51.0%, (95% CI: 0.449, 0.575) than among the younger (P = 49.0%, (95% CI: 0.375, 0.611).

3.3. Prevalence by type of test

The prevalence of Schistosomiasis varied by diagnostic method. Using the KETO-KATZ technique, the prevalence of *S. Mansoni* infection was 24.0%, (95% CI: 0.19, 0.29) whereas detected *S. haematobium* infection in 36.0% (95% CI: 0.30, 0.41) of participants. Prevalence was higher among female children for both the KETO-KATZ 26.0%, (95% CI: 0.19, 0.35) and Urine filtration 40.0%, (95% CI: 0.31, 0.49) than their male counterparts using both KETO-KATZ 22.0%, (95% CI: 0.16, 0.29) and Urine filtration 33.0%, 95% CI: 0.26, 0.40). Similarly, older children had higher prevalence estimates than younger children across both tests (KETO-KATZ 24.0% (95% CI: 0.19, 0.30) and Urine filtration 37.0%, (95% CI: 0.30, 0.43) and KETO-KATZ 22.0%, (95% CI: 0.13, 0.34) and Urine filtration 33.0% (95% CI: 0.22, 0.45) respectively.

Table 1: Prevalence by type of test

		N	***n [prevalence]***	***95 % CI***	***P-value***
KETO-KATZ		309	73[0.24]	[0.19, 0.29]	
Gender					0.357
	Female	126	33 [0.26]	[0.19, 0.35]	
	Male	183	40 [0.22]	[0.16, 0.29]	
Age group					0.775
	< 2 years	67	15[0.22]	[0.13, 0.34]	
	> 2 years	241	58[0.24]	[0.19, 0.30]	
Filtration		309	110 [0.36]	[0.30, 0.41]	
Gender					0.195
	Female	126	50[0.40]	[0.31, 0.49]	
	Male	183	60[0.33]	[0.26, 0.40]	
Age group					0.579
	< 2 years	67	22[0.33]]	[0.22, 0.45]	
	> 2 years	242	88[0.37]	[0.30, 0.43]	

3.4. Bivariable logistic regression analyses

To identify the factors associated with schistosomiasis infection, Bivariable logistic regression analysis was performed. Variables including previous illness history, water source for domestic use, and prior administration of Albendazole met the inclusion threshold p-value of 0.2.for multivariable analysis. Aged and gender were retained based on theoretical relevance.

Table 3: presents unadjusted odds ratios (ORs) and their 95% Cis, including their corresponding p-values.

Table 3: Bivariable Analysis: Associations between independent variables and Prevalence of Schistosomiasis (*n* = 309)

Prevalence of Schistosomiasis	**Un adj. OR**	**95% CI for OR**	***P*-value**
Age	1.08	(0.630, 1.860)	0.774*
Gender	0.81	(0.513, 1.272)	0.357*
Proximity to the river	0.97	(0.060, 15.615)	0.982
Contact with water	1.34	(0.587, 3.047)	0.489
Frequency of contact with river water	1.22	(0.778, 1.901)	0.391
Water quality for home use	1.57	(0.832, 2.960)	0.164**
Sanitation and hygiene in home	0.93	(0.694, 1.249)	0.634
Level of parental education	0.65	(0.387, 1.105)	0.112
previous illness prior to the study	0.60	(0.357, 1.022)	0.060**
Albendazole given prior to the study	2.67	(0.694, 10.247)	0.153*
Sanitation and hygiene knowledge	0.89	(0.518, 1.540)	0.684
Contact with cattle water	1.51	(0.559, 4.072)	0.417
Received prevention services prior to the study	1.18	(0.756, 1.846)	0.465

Note: * Potential theory-based predictors, ** Potential empirical-based predictors (i.e. p < 0.2)

Results indicate that previous illness prior to the study (p = 0.060), Albendazole given prior to the study (p =0 .153), and Water quality for home use (p =0 .164) are potential empirical-based predictors as the p-value < 0.2 (the threshold p-value) and Age and gender are potential theory-based predictors. All independent variables are not significantly associated with Prevalence of Schistosomiasis in the Bivariable analyses (p >0 .05)

3.5. Multivariable Logistic Regression Analyses

Variables identified in the Bivariable analysis were included in multivariable logistic regression model to determine independent predictors of schistosomiasis infection. In the adjusted model, prior previous history of schistosomiasis-related illness was significantly associated with lower odds of infection (Adjusted OR = 0.57; 95% CI: 0.33–0.97; p<0.05). Other variables, including age, gender, sanitation status, and water source, prior Albendazole use, were not statistically significant after adjustment**.** Model comparison indicated no significant improvement in fit after inclusion of age and gender (Like hood ratio test:X^2 (2) =0.60, p=0.741). However, the model including these variables demonstrated slightly better predictive performance. Two hierarchical logistic regression models were fitted to assess predictors of Schistosomiasis. Model 1 (M1) included three empirically identified predictors; previous illness prior to the study, Albendazole given prior to the study, and Water quality for home use, while model 2 (M2) added two theory-based predictors (Age and gender).

Table 4. Multivariable Model of factors associated with schistosomiasis infection.

Parameter	**M1**	**M2**
Intercept	0.811	1.103
Previous illness prior to the study	0.565*	0.567*
Water quality for home use	1.494	1.554
Albendazole given prior to the study	3.061	3.002
Age	-	0.897
gender	-	0.852
Statistics		
ll	-209.986	-209.686
aic	427.973	431.372
bic	442.906	453.772

Note: * $p<0.05$; ** $p<0.01$; *** $p<0.001$, ll = Log-likelihood, aic = Akaike Information Criteria, bic = Bayesian Information Criteria

Results from the initial model (M1) indicate that the variable *previous illness prior to the study* was significantly associated with prevalence of Schistosomiasis ($p < 0$ .05). Thus, children who had previous illness prior to the study lower odds of a positive Schistosomiasis result (Adj. OR = 0.57, 95% CI: 0.329, 0.969). Water quality for home use and whether Albendazole was given prior to the study were not statistically significantly associated with prevalence of Schistosomiasis at 5% level of significance ($p \geq .05$). When Age and gender were added to the model based on theoretical considerations, the overall model fit did not significantly improve compared to the base model (Likelihood ratio test: $\chi^2(2) = 0.60$, $p = .741$). Both Age (Adj. OR = 0.897, 95% CI: 0.502, 1.600) and gender (Adj. OR = 0.852, 95% CI: 0.537, 1.353) were not statistically significant. The information criteria in the initial model seem to be smaller (AIC = 427.973) than in the model with Age and gender added (431.372) suggesting that the model without Age and gender could be a better fit to the data.

On the contrary, when the two models were assessed on their predictive ability, the model with Age and gender proved to have greater predictive ability than the initial model (Figure …)

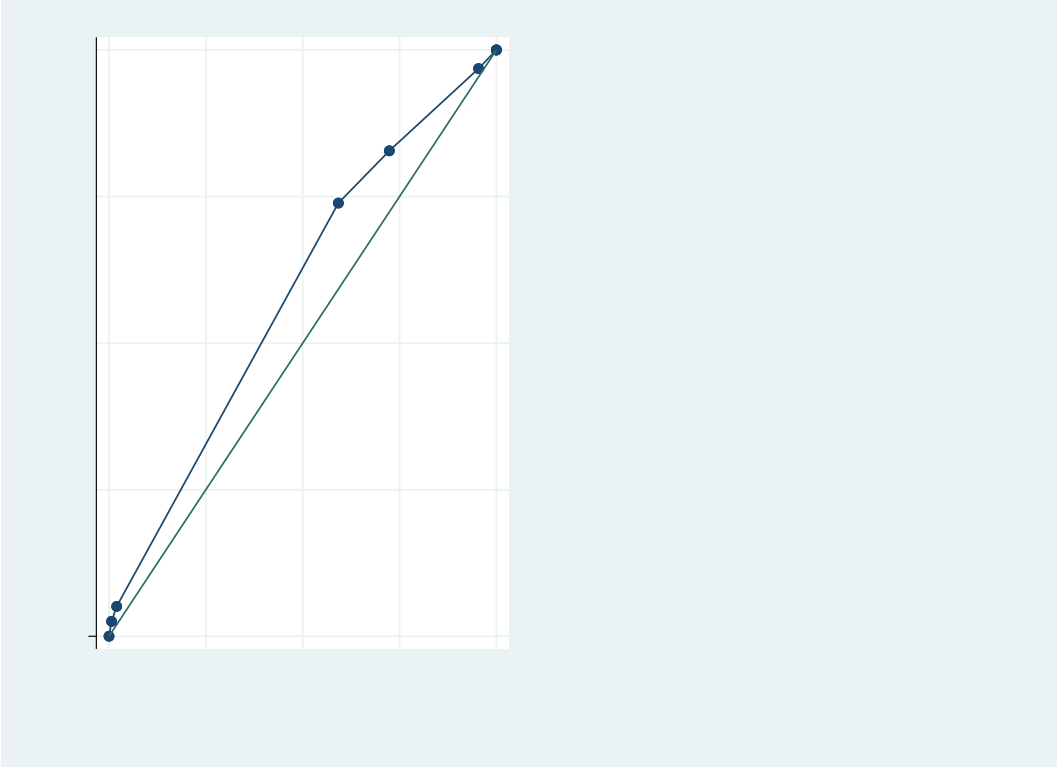


Figure 2: Predictive ability of the model without Age and gender (Left) and the model with Age and gender added (Right)

Results suggest that Model 2 (Right) is able to correctly predict Prevalence of Schistosomiasis among the Pre-School Aged children about 60.3% of the times compared to Model 1 (Left), which is able to correctly predict the prevalence about 58.2% of the times. Therefore, both Age and gender were retained in the second model based on its higher predictive ability, as well as, prior theoretical evidence linking socioeconomic characteristics to Schistosomiasis risk. Their non-significance in the dataset may reflect limited variability, measurement differences or other factors linked to the study population such as small sample size and small study area.

3.6. Results Summary

The study has found that the prevalence of Schistosomiasis was 0.51, higher among female children (0.54) than among males (0.49), and slightly higher among the older children (0.51) than among the younger (0.49). In terms of risk factors for Schistosomiasis among school children, the study has found that having a known history of *previous illness prior to the study* was significantly associated with prevalence of Schistosomiasis than having no known history. In addition, adding Age and gender does not significantly improve model fit compared to the

base model. Although this was the case, both Age and gender were retained in the second model based on its higher predictive ability, as well as, prior theoretical evidence linking socioeconomic characteristics to Schistosomiasis risk.

4.0. DISCUSSION

4.0.1. Summary of major findings and Interpretation of major findings

This study assessed the prevalence and determinants of schistosomiasis among PSAC in Lilongwe District. I found an overall prevalence of 51%, with both *Schistosoma mansoni* (24%) and *S. haematobium* (36%) being identified. Mixed infections were present in 8.4% of PSAC. The high overall prevalence observed indicates that PSAC in the study area are highly exposed to schistosomiasis transmission. Nearly all households (99.3%) were located within one kilometer of a river, and the majority of children (91.8%) reported direct river water contact. This proximity and exposure strongly explain the high infection rates observed. The predominance of *S. haematobium* aligns with the ecological suitability of rivers and stagnant water bodies in the study setting, which favor snail populations, the intermediate hosts for schistosomiasis. The higher prevalence among older PSAC is consistent with behavioral factors, as children above two years are more mobile, spend more time playing outdoors, and often accompany caregivers to water bodies. The predominance of *S. haematobium* infection, alongside substantial *S. mansoni* prevalence and co-infection, reflects the ecological suitability of the Lilongwe River for multiple Schistosome species and their intermediate snail hosts. Similar patterns of dual transmission have been documented in lakeshore and riverine settings in Malawi, Uganda, and Tanzania, where frequent human–water contact sustains ongoing transmission.

The prevalence found in this study is consistent with findings from a similar study in Chikhwawa Malawi where the prevalence was reported at 49.5% **(Poole H et al,2014)** suggesting that water contact during bathing and household chores contributes significantly to early exposure. Similarly, a study in Uganda found slightly higher prevalence of *S. haematobium* compared to *S. Manson* where the prevalence was 44.5 % and 59.3% in one geographical area of Lake Albert and 13.2% and 43.2% at Lake Victoria respectively **(Stothard JR et al,2013).** Contrary to these findings were found in a study in South Africa where *S. mansoni* and *S. haematobium* were 0.9% and 1.0 % respectively **(Sacolo-Gwebu H et al,2020).** A lower prevalence was also recorded in a study in Ethiopia with a prevalence rate of 16.7% for *S. haematobium* **(Mohammed T et al,2025).** The differences in the findings could be due differences in the geographical locations

and the control measures put in place. The predominance of *S. haematobium* in this study is consistent with findings from a study in Côte d'Ivoire **(Coulibaly JT et al,2013).** By contrast, a study in Uganda **(Odogwu SE et al,2006).** and a systematic review done in 2016 reported *S. mansoni* as the predominant species demonstrating the influence of ecological conditions, snail vector distribution, and water body type on species-specific transmission **(Kittur N et al,2016).** Infection was more common among children older than two years, and males had slightly higher prevalence, although gender differences were not statistically significant. These findings are in consistent with a study in South Africa **(Sacolo-Gwebu H et al,2019).** and Tanzania where gender and age were not associated with schistosomiasis. In contrast, a study in Kenya **(Ng'weng'weta SB et al,2016.** found increased odds for the infection was found among PSAC of four years old and five years and among girls.

Previous illness prior to the study was a protective factor for having schistosomiasis with odds of 0.50 and CI [0.28-0.92]. The association of previous illness with reduced schistosomiasis prevalence is an unexpected finding. One possible explanation is that children who had recent illness were restricted in outdoor or water activities, thereby reducing their exposure. It could also be that health-seeking behavior for prior illness led to incidental treatment with Albendazole or praziquantel in health facilities, which might have reduced parasite burden although there were no records of receiving praziquantel in this study. Education level, water quality for home use, river water contact, and proximity to the river were also not associated with the risk for schistosomiasis. Contrary to this, a study in South Africa **(Sacolo-Gwebu H et al,2019)** found that odds for schistosomiasis was higher among PSAC who had river water contact. In Burkina Faso **(Cisse M et al,2021)** found that PSAC closer to the ponds were 3 times more likely to have schistosomiasis. A study in Ethiopia found that the odds of the infection was higher among PSAC who played or bathed in infested water **(Mohammed T et al,2025).** The lack of association here could be due to relative homogeneity of the study population, where most parents had only primary education and households shared similar sanitation and water access. The absence of variability in these exposures makes it difficult to detect significant associations.

4.0.2. Studies Reporting low or negligible prevalence of schistosomiasis among PSAC

This study reports a high prevalence (51%) of Schistosomiasis among PSAC along West banks the Lilongwe River. Several studies from endemic areas in Africa setting have reported much lower prevalence that suggest PSAC may not always represent a high-burden group. Sacolo-

Gwebu al.(2020) reported a very low prevalence of *S.heamatobium* (1.0%) and S.*Mansoni* (0.9%) among PSAC in South Africa, attributing to improved water access, sanitation infrastructure, and sustained control programs. These findings contradict my findings indicating that environmental and programmatic contexts strongly modify risks. Said et al. (2017), in an urban Tanzanian setting, reported a prevalence of only 15.8% among children, substantially lower than that observed in Lilongwe west banks population. These findings suggest that high prevalence among PSAC is not uniform across endemic setting and is highly dependent on ecological, behavioral, and infrastructure factors.

4.0.3. Studies showing no significant association between age and infection among PSAC

My study has found that prevalence and intensity increased with age, especially among children older than two years. However, some studies did not observe a clear age-related gradient within the PSAC group. Poole et al.(2014) in Chikwawa District, Malawi, found no statistically significant association between age and egg-patent infection among PSAC, despite evidence of exposure based on antigen and antibody detection. These observation contradicts my study which is increasing prevalence with age. Moyo et al. (2016) in Nkhotakota similarly reported that while exposure was evident across all PSAC age groups, age was not a strong predictor of infection, suggesting that even very young children are exposed early through caregiver-mediaed water contact. This suggest that within PSAC, infection may occur very early in life,limiting the observable effect of age as a determinant in some settings.

Age-related increases prevalence and infection intensity observed in this study are consistent with previous findings, suggesting cumulative exposure as children grow older and become more mobile active. Importantly, the detection of infection among children younger than two years highlights that exposure begins very early in life, largely through passive water contact during caregiver-led activities such as bathing and household water use.

An unexpected but notable finding was the association between a prior history of schistosomiasis-related illness and reduced odds of current infection. This may reflect partial acquired immunity following repeated exposure or prior treatment received through health facilities outside routine mass drug administration programmes. Similar observations have been reported in endemic settings, where previous treatment or immune priming may temporarily reduce reinfection risk, although protection is often incomplete and short-lived.

4.0.4. Studies contradicting the protective effect of prior schistosomiasis-related illness.

My multivariable analysis showed that a history of prior schistosomiasis-related illness was associated with lower odds of current infection, possibly due to partial immunity or prior treatment. However, some studies do not support this protective effect. Mutapi et al. (2011) demonstrated that prior infection or morbidity does not reliably confer protective immunity, especially in young children, due to immature immune responses and ongoing exposure. Reinfection occurred rapidly following treatment, contradicting the notion of sustained protection Stothard et al. (2013) reported high reinfection rates among PSAC in Uganda despite previous treatment, indicating that prior illness or treatment does not necessarily reduce subsequent infection risk. Colley et al, (2014) emphasized that immunity to schistosomiasis is slowly acquired and incomplete, particularly in children, challenging interpretations that prior illness alone can be protective. These findings suggest that the protective association observed in my study may reflect unmeasured confounders.

The extremely high proportion of households located near the river and the widespread reliance on river water emphasize the central role of environmental and structural determinants in sustaining transmission. Inadequate access to safe water and sanitation limits the effectiveness of preventive chemotherapy alone and highlights the need for integrated control strategies that combine MDA with improvements in water, sanitation, and hygiene (WASH), alongside health education targeted at caregivers.

The exclusion of PSAC from routine MDA programmes in Malawi represents a critical programmatic gap. Given the high prevalence observed in this study, untreated PSAC may act as a persistent reservoir of infection, undermining national schistosomiasis control and elimination efforts. The recent development of paediatric praziquantel formulations presents an opportunity to close this gap and align national programmes with WHO recommendations.

4.0.5. Relevance and contribution to science and policy

The findings underscore the urgent need to include PSAC in schistosomiasis control strategies in Malawi. Currently, MDA programs largely target school-aged children, yet this study demonstrates that PSAC carry a substantial burden of infection. This has implications for morbidity, including anaemia, malnutrition, and impaired cognitive development, which can begin in early childhood **(Ezeamama AE et al,2008.).** Additionally, the exclusion of PSAC from

preventive chemotherapy programs overlooks a significant reservoir of infection and risks delaying the achievement of WHO's 2030 targets for schistosomiasis elimination Policies should be updated to ensure access to praziquantel formulations suitable for younger children as WHO guidelines now recommend treatment of this age group, given accumulating evidence of significant infection burdens and associated morbidity **(World Health Organization, 2022).**

Caregiver-targeted health education on water contact and safe play practices may help reduce exposure. Furthermore, integrated approaches that combine preventive chemotherapy with improved water, sanitation, and snail control should be prioritized.

Future research should explore the role of incidental treatments during routine healthcare visits, and assess the effectiveness and safety of praziquantel in this age group under programmatic conditions. Such evidence will be critical to inform national control strategies and contribute to global goals for schistosomiasis elimination.

5. Study strengths and limitations

A key strength of this study is the use of parasitological confirmation for both urogenital and intestinal schistosomiases in a neglected population group. However, the use of single stool and urine samples may have underestimated true prevalence due to the limited sensitivity of microscopy, particularly in light infections. Additionally, the cross-sectional design precludes causal inference.

6. Public health implications

The findings provide strong evidence to support the inclusion of PSAC in schistosomiasis surveillance and preventive chemotherapy in Malawi. Targeted interventions in high-risk riverine communities, combined with caregiver-focused health education and WASH improvements, are essential to reduce early-life exposure and advance schistosomiasis elimination goals.

7. Conclusion

In conclusion, this study establishes a high prevalence of schistosomiasis among pre-school-aged children living along the west banks of the Lilongwe River in Malawi, indicating intense and early-life exposure to both *Schistosoma haematobium* and *Schistosoma mansoni* contributing significantly. The findings confirm that PSAC constitute a highly vulnerable but neglected population group in schistosomiasis control efforts. Early exposure, widespread water contact,

and limited access to safe water and sanitation contribute to sustained transmission in this riverine setting. Age above two years was associated with higher infection risk, while previous illness appeared protective. Unlike other studies, parental education, sanitation, and hygiene were not significant determinants, likely due to homogeneity of exposure. The findings highlight the vulnerability of PSAC and the need to extend control measures to this neglected age group. It could be extremely higher if the study involved the whole Lilongwe district and also very alarming if the study involved more districts in Malawi. Kato-Katz is a diagnostic method of schistosomiasis which has high sensitivity combining for stool and filtration for urine. The Prevalence 51% is so huge that requires serious interventions. Inclusion of PSAC to mass praziquantel drug distribution is Paramount to reduction of Schistomiasis in Malawi. The best intervention is the inclusion of PSAC group to Mass drug (Praziquantel) distribution in Malawi. The Prevalence can be reduced when PSAC population is included and closely monitored as part of a comprehensive national schistosomiasis control program. To achieve control and elimination of schistosomiasis, WHO suggests that preventive chemotherapy in PSAC is appropriate for those aged ≥2 years while for children under 2 years, a test and-treat approach is recommended. With a pediatric formulation of praziquantel under development, WHO recommendations for PSAC suggest their inclusion in large-scale treatment campaigns in areas where the prevalence is above a 10% threshold. The findings from this research, support the recommendation by WHO to systematically consider PSAC in endemic areas, including among hard-to-reach populations when planning schistosomiasis control and elimination interventions. In parallel to chemotherapy, WHO also recommends implementing health education interventions along with improving access to adequate sanitation and safe drinking water as part of an integrated control approach.

8.0. Recommendations from this study.

8.0.1. Inclusion of PSAC in MDA programmes

Including PSAC in Mass (praziquantel) administration, Community engagement and participation are expedient tools in reducing the burden of NTDs. Multiple studies have reported that in addition to improving the effectiveness of Mass drug Administration in all populations will reduce the infection incidence only if PSAC is included in the program.

Malawi's National Schistosomiasis Control Programme should prioritize the inclusion of PSAC in preventive chemotherapy, particularly in high-risk riverine communities, in line with WHO

recommendations. Multiple studies have reported that in addition to improving the effectiveness of Mass drug Administration in all populations will combat reduce the infection incidence only if PSAC is included in the program. Routine surveillance systems should be expanded to include PSAC to ensure accurate estimation of disease burden and guide targeted intervention. Preventive chemotherapy should be complemented with improved access to safe water, sanitation, hygiene (WASH), and caregiver-focused health education to reduce early-life exposure.

9.0. Further research

Longitudinal studies are recommended to assess reinfection dynamics, morbidity outcomes, and the long-term impact of early treatment among PSAC.

10.0. Author statements

10.1. Data Availability

The data that support the findings of this study is available from the corresponding author upon reasonable request.

10.2. Disclaimer

The views expressed in this manuscript are those of the Author and do not necessarily reflect the official positions of my affiliated institutions.

10.3. Ethical considerations

Ethical approval for the study was obtained from the relevant institutional ethics review boards such as Levy Mwanawasa Medical University research board in Lusaka, Zambia and National Health Research and Science Technology Committee in Lilongwe, Malawi respectively. Permission to conduct the study in the area was granted by district health authorities and District Commissioner in conjunction with community leaders.

10.4. Informed Consent

Written informed consent was obtained from caregivers prior to participation. Participant confidentiality was maintained by assigning unique identification codes to each participant and securely storing all data in password-protected databases accessible only to the research team.

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10.7. Conflict of Interest

I declare there are no conflicts of interests.

11.0. REFERENCE

1. [i] WHO, Schistosomiasis (Bilharzia),2024
2. [ii] Kebabonye P. Gabaake et al. Assessment of awareness and knowledge of schistosomiasis among school-aged children (6–13 years) in the Okavango Delta, Botswana. BMC, 2022
3. [iii] OUP Academics, Relationships Between Schistosoma mansoni Infection Intensity and Nutritional Status and Anemia Among Preschool-aged Children in Uganda, ,2023.
4. [iv] OUP Academics, Relationships Between Schistosoma mansoni Infection Intensity and Nutritional Status and Anemia Among Preschool-aged Children in Uganda, OUP Academic,2023.
5. [v] World Health Organization. Ending the neglect to attain the Sustainable Development Goals: a roadmap for neglected tropical diseases 2021–2030. Geneva: WHO; 2020.
6. [vi] Humphrey Mazigo, et al, 2019.
7. [vii] Humphrey Mazigo,et al, 2019.
8. [viii] Lim RM et al,2020.
9. [ix] Stothard JR, Sousa-Figueiredo JC, Betson M, et al. Schistosomiasis in African infants and preschool children: to treat or not to treat? Trends Parasitol. 2013;29(2):83–90.

10. [x] Wade, T. J., Arnold, B. F., Schiff, K., Colford Jr, J. M., Weisberg, S. B., Griffith, J. F., & Dufour, A. P. (2022). *Health risks to children from exposure to fecally-contaminated recreational water*. PLoS ONE, 17(4), e0266749.
11. [xi] Stothard JR, Sousa-Figueiredo JC, Betson M, et al. Schistosomiasis in African infants and preschool children: to treat or not to treat? Trends Parasitol. 2013;29(2):83–90.
12. [xii] Stothard JR, Sousa-Figueiredo JC, Betson M, et al. Schistosomiasis in African infants and preschool children: to treat or not to treat? Trends Parasitol. 2013;29(2):83–90; Kabatereine et al., 2010 – PSAC prevalence and risk factors
13. [xiii] World Health Organization. Preventive chemotherapy in human helminthiasis: coordinated use of anthelminthic drugs in control interventions. Geneva: World Health Organization; 2006.
14. [xiv] Kabatereine NB, Tukahebwa EM, Kazibwe F, et al. Schistosomiasis in pre-school children in Uganda: prevalence and risk factors. Trop Med Int Health. 2010;15(8):921–929.
15. [xv] Bowie C, Purcell B, Shaba B, Makaula P, Perez M. A national survey of the prevalence of schistosomiasis and soil-transmitted helminths in Malawi. BMC Infect Dis. 2014;14:49.
16. [xvi] Mazigo HD, Nuwaha F, Kinung'hi SM, et al. Epidemiology and control of human schistosomiasis in Tanzania. Parasit Vectors. 2012;5:274.
17. [xvii] Poole H, Terlouw DJ, Naunje A, et al. Schistosomiasis in preschool-aged children and their mothers in Malawi. Am J Trop Med Hyg. 2014;90(2):312–317.
18. [xviii] Poole, H. et al. (2014) 'Schistosomiasis in pre-school-age children and their mothers in Chikhwawa district, Malawi', Parasites & Vectors, 7, p. 153
19. [xix] Moyo et al., Urinary schistosomiasis among preschool children in Malengachanzi, Nkhotakota District, Malawi: Prevalence and risk factors (2016)
20. [xx] Katipo et al.(2009) Prevalence distribution and Risk factors for Schistosoma haematobium infection among School Children in Blantyre, 2009
21. [xxi] Hotez PJ, Kamath A. Neglected tropical diseases in sub-Saharan Africa: review of their prevalence, distribution, and disease burden. PLoS Negl Trop Dis. 2009;3(8):e412.
22. [xxii] World Health Organization. Ending the neglect to attain the Sustainable Development Goals: a roadmap for neglected tropical diseases 2021–2030. Geneva: WHO; 2020.
23. [xxiii] However, recent epidemiological data on schistosomiasis prevalence and associated determinants among PSAC in this area are scarce. Generating localized evidence is essential for informing targeted interventions, strengthening surveillance systems, and supporting Malawi's National Schistosomiasis Control Programme in alignment with the World Health Organization (WHO) 2030 NTD Roadmap.
24. Adenowo AF, Oyinloye BE, Ogunyinka BI, Kappo AP. Impact of human schistosomiasis in sub-Saharan Africa. Brazilian J Infect Dis an Off Publ Brazilian Soc Infect Dis. 2015;19[2]:196–205.
25. Gabaake KP, Phaladze NA, Lucero-Prisno Iii DE, Thakadu OT. Assessment of awareness and knowledge of schistosomiasis among school-aged children [6-13 years] in the Okavango Delta, Botswana. Glob Heal Res policy. 2022 Sep;7[1]:36.
26. Tembo R, Muleya W, Yabe J, Kainga H, Nalubamba KS, Zulu M, et al. Prevalence and

Molecular Identification of Schistosoma haematobium among Children in Lusaka and Siavonga Districts, Zambia. Trop Med Infect Dis. 2022 Sep;7[9].

27. World Health Organization G. WHO guidelines on the control and elimination of human schistosomiasis [Internet]. 2022. Available from: https://iris.who.int/bitstream/handle/10665/351856/9789240041608-eng.pdf?sequence=1
28. Gryseels B, Polman K, Clerinx J, Kestens L. Human schistosomiasis. Lancet [Internet]. 2006 Sep 23;368[9541]:1106–18. Available from: https://doi.org/10.1016/S0140-6736[06]69440-3
29. Stothard JR, Sousa-Figueiredo JC, Betson M, Bustinduy A, Reinhard-Rupp J. Schistosomiasis in African infants and preschool children: let them now be treated! Trends Parasitol. 2013 Apr;29[4]:197–205.
30. Kokaliaris C, Garba A, Matuska M, Bronzan RN, Colley DG, Dorkenoo AM, et al. Effect of preventive chemotherapy with praziquantel on schistosomiasis among school-aged children in sub-Saharan Africa: a spatiotemporal modelling study. Lancet Infect Dis. 2022 Jan;22[1]:136–49.
31. King CH, Bertsch D. Historical perspective: snail control to prevent schistosomiasis. PLoS Negl Trop Dis. 2015 Apr;9[4]:e0003657.
32. Woolhouse ME. Patterns in parasite epidemiology: the peak shift. Parasitol Today. 1998 Oct;14[10]:428–34.
33. Verjee M. Schistosomiasis: Still a Cause of Significant Morbidity and Mortality. Res Rep Trop Med. 2019 Dec 31;10:153–63.
34. Hotez PJ, Kamath A. Neglected tropical diseases in sub-saharan Africa: review of their prevalence, distribution, and disease burden. PLoS Negl Trop Dis. 2009 Aug;3[8]:e412.
35. Poole H, Terlouw DJ, Naunje A, Mzembe K, Stanton M, Betson M, et al. Schistosomiasis in pre-school-age children and their mothers in Chikhwawa district, Malawi with notes on characterization of schistosomes and snails. Parasit Vectors. 2014 Apr;7:153.
36. Teesdale CH, Chitsulo L. Schistosomiasis in Malawi--a review. Trop Med Parasitol Off organ Dtsch Tropenmedizinische Gesellschaft Dtsch Gesellschaft fur Tech Zusammenarbeit. 1985 Mar;36[1]:1–6.
37. Makaula P, Kayuni SA, Mamba KC, Bongololo G, Funsanani M, Musaya J, et al. An

assessment of implementation and effectiveness of mass drug administration for prevention and control of schistosomiasis and soil-transmitted helminths in selected southern Malawi districts. BMC Health Serv Res. 2022 Apr;22[1]:517.

38. Moyo V, Changadeya W, Chiotha S, Sikawa D. Urinary schistosomiasis among preschool children in Malengachanzi, Nkhotakota District, Malawi: Prevalence and risk factors. Malawi Med J J Med Assoc Malawi. 2016 Mar 1;28:10–4.
39. Prevention and control of schistosomiasis and soil-transmitted helminthiasis. World Health Organ Tech Rep Ser. 2002;912:i–vi, 1–57, back cover.
40. World Health Organization. Schistosomiasis [Internet]. 2023. Available from: https://www.who.int/news-room/fact-sheets/detail/schistosomiasis
41. Colley DG, Bustinduy AL, Secor WE, King CH. Human schistosomiasis. Lancet [London, England]. 2014 Jun;383[9936]:2253–64.
42. Collaboration GB of DP. Global and National Burden of Diseases and Injuries Among Children and Adolescents Between 1990 and 2013: Findings From the Global Burden of Disease 2013 Study. JAMA Pediatr [Internet]. 2016 Mar 1;170[3]:267–87. Available from: https://doi.org/10.1001/jamapediatrics.2015.4276
43. Ekpo UF, Laja-Deile A, Oluwole AS, Sam-Wobo SO, Mafiana CF. Urinary schistosomiasis among preschool children in a rural community near Abeokuta, Nigeria. Parasit Vectors. 2010 Jul;3:58.
44. Mafiana CF, Ekpo UF, Ojo DA. Urinary schistosomiasis in preschool children in settlements around Oyan Reservoir in Ogun State, Nigeria: implications for control. Trop Med Int Health. 2003 Jan;8[1]:78–82.
45. Ruganuza DM, Mazigo HD, Waihenya R, Morona D, Mkoji GM. Schistosoma mansoni among pre-school children in Musozi village, Ukerewe Island, North-Western-Tanzania: prevalence and associated risk factors. Parasit Vectors. 2015 Jul;8:377.
46. Said K, Hella J, Knopp S, Nassoro T, Shija N, Aziz F, et al. Schistosoma, other helminth infections, and associated risk factors in preschool-aged children in urban Tanzania. PLoS Negl Trop Dis. 2017 Nov;11[11]:e0006017.
47. Exum NG, Kibira SPS, Ssenyonga R, Nobili J, Shannon AK, Ssempebwa JC, et al. The prevalence of schistosomiasis in Uganda: A nationally representative population estimate to inform control programs and water and sanitation interventions. PLoS Negl Trop Dis

[Internet]. 2019 Aug 14;13[8]:e0007617. Available from: https://doi.org/10.1371/journal.pntd.0007617

48. Sacolo-Gwebu H, Chimbari M, Kalinda C. Prevalence and risk factors of schistosomiasis and soil-transmitted helminthiases among preschool aged children [1–5 years] in rural KwaZulu-Natal, South Africa: a cross-sectional study. Infect Dis Poverty [Internet]. 2019;8[1]:47. Available from: https://doi.org/10.1186/s40249-019-0561-5
49. Bowie C, Purcell B, Shaba B, Makaula P, Perez M. A national survey of the prevalence of schistosomiasis and soil transmitted helminths in Malawi. BMC Infect Dis. 2004 Nov;4:49.
50. Steinmann P, Keiser J, Bos R, Tanner M, Utzinger J. Schistosomiasis and water resources development: systematic review, meta-analysis, and estimates of people at risk. Lancet Infect Dis [Internet]. 2006 Jul 1;6[7]:411–25. Available from: https://doi.org/10.1016/S1473-3099[06]70521-7
51. McManus DP, Dunne DW, Sacko M, Utzinger J, Vennervald BJ, Zhou X-N. Schistosomiasis. Nat Rev Dis Prim. 2018 Aug;4[1]:13.
52. Ekpo UF, Hürlimann E, Schur N, Oluwole AS, Abe EM, Mafe MA, et al. Mapping and prediction of schistosomiasis in Nigeria using compiled survey data and Bayesian geospatial modelling. Geospat Health. 2013 May;7[2]:355–66.
53. Nelwan ML. Risk factors for schistosomiasis. Water Supply. 2024;24[11]:3796–809.
54. Mutsaka-Makuvaza MJ, Matsena-Zingoni Z, Katsidzira A, Tshuma C, Chin'Ombe N, Zhou XN, et al. Urogenital schistosomiasis and risk factors of infection in mothers and preschool children in an endemic district in Zimbabwe. Parasites and Vectors [Internet]. 2019;12[1]:1–15. Available from: https://doi.org/10.1186/s13071-019-3667-5
55. Mohammed T, Degarege A, Aemero M, Animut A, Negash Y, Gebrehiwot Y, et al. Schistosoma haematobium infection and associated risk factors among pre-school age children in Gambella, Ethiopia. Parasite Epidemiol Control [Internet]. 2025;30:e00448. Available from: https://www.sciencedirect.com/science/article/pii/S2405673125000418
56. Sánchez-Marqués R, Salvador F, Bocanegra C, Nindia A, Pintar Z, Martínez J, et al. Schistosoma haematobium infection and morbidity risk factors for pre-school age children in western Angola: A knowledge, attitudes and practices survey. PLoS Negl Trop Dis [Internet]. 2023 Oct 16;17[10]:e0011650. Available from:

https://doi.org/10.1371/journal.pntd.0011650

57. Cisse M, Sangare I, Djibougou AD, Tahita MC, Gnissi S, Bassinga JKW, et al. Prevalence and risk factors of Schistosoma mansoni infection among preschool-aged children from Panamasso village, Burkina Faso. Parasit Vectors [Internet]. 2021;14[1]:185. Available from: https://doi.org/10.1186/s13071-021-04692-8
58. Lim RM, Woolhouse MEJ, Mduluza T, Chase-Topping M, Osakunor DNM, Chitsulo L, et al. Investigating a strategy for quantifying schistosome infection levels in preschool-aged children using prevalence data from school-aged children. PLoS Negl Trop Dis. 2020 Oct;14[10]:e0008650.
59. Danso-Appiah A, De Vlas SJ. Interpreting low praziquantel cure rates of Schistosoma mansoni infections in Senegal. Trends Parasitol. 2002 Mar;18[3]:125–9.
60. King CH, Sturrock RF, Kariuki HC, Hamburger J. Transmission control for schistosomiasis - why it matters now. Trends Parasitol. 2006 Dec;22[12]:575–82.
61. Coulibaly JT, N'Gbesso YK, N'Guessan NA, Winkler MS, Utzinger J, N'Goran EK. Epidemiology of schistosomiasis in two high-risk communities of south Cote d'Ivoire with particular emphasis on pre-school-aged children. Am J Trop Med Hyg. 2013 Jul;89[1]:32–41.
62. Odogwu SE, Ramamurthy NK, Kabatereine NB, Kazibwe F, Tukahebwa E, Webster JP, et al. Schistosoma mansoni in infants [aged < 3 years] along the Ugandan shoreline of Lake Victoria. Ann Trop Med Parasitol. 2006 Jun;100[4]:315–26.
63. Kittur N, Castleman JD, Campbell CH, King CH, Colley DG. Comparison of Schistosoma mansoni Prevalence and Intensity of Infection, as Determined by the Circulating Cathodic Antigen Urine Assay or by the Kato-Katz Fecal Assay: A Systematic Review. Am J Trop Med Hyg. 2016 Mar;94[3]:605–10.
64. Ng'weng'weta SB, Tarimo DS. Urinary schistosomiasis among preschool-age children in an endemic area of Kinondoni municipality, Dar es Salaam, Tanzania 2016. 2017;
65. Isaiah PM, Nyawanda B, Okoyo C, Oloo JO, Steinmann P. Schistosomiasis status and health impact in preschool-aged children in hard-to-reach areas and populations of Homa Bay County, Kenya. Acta Trop [Internet]. 2025;261:107511. Available from: https://www.sciencedirect.com/science/article/pii/S0001706X24003954
66. Ezeamama AE, McGarvey ST, Acosta LP, Zierler S, Manalo DL, Wu H-W, et al. The

synergistic effect of concomitant schistosomiasis, hookworm, and trichuris infections on children's anemia burden. PLoS Negl Trop Dis. 2008 Jun;2[6]:e245.

67. Friedman JF, Kanzaria HK, McGarvey ST. Human schistosomiasis and anemia: the relationship and potential mechanisms. Trends Parasitol. 2005 Aug;21[8]:386–92.
68. World Health Organization. WHO schistosomiasis fact sheet; 2014. Available from: http://www.who.int/mediacentre/factsheets/fs115/en [accessed 10.04.14].
69. Gryseels B, Polman K, Clerinx J, Kestens L. Human schistosomiasis. Lancet.2006.
70. Steinmann P, Keiser J, Bos R, Tanner M, Utzinger J. Schistosomiasis and water resources development: systematic review, meta-analysis, and estimates of people at risk. Lancet Infect Dis. 2006; 6:411-25.
71. World Health Organization. WHO schistosomiasis fact sheet; 2014. Available from: http://www.who.int/mediacentre/factsheets
72. Derick N. M. Osakunor, Mark E. J. Woolhouse, Francisca Mutapi: Paediatric schistosomiasis: What we know and what we need to know : Neglected Tropical Diseases,2018.
73. Mutapi F. Changing policy and practice in the control of pediatric schistosomiasis. Pediatrics. 2015;
74. Garba A, Barkire N, Djibo A, Lamine MS, Sofo B, Gouvras AN, et al. Schistosomiasis in infants and preschool-aged children: Infection in a single *Schistosoma haematobium* and a mixed *S. haematobium-S. mansoni*, 2010.
75. Odogwu SE, Ramamurthy NK, Kabatereine NB, Kazibwe F, Tukahebwa E, Webster JP, et al. *Schistosoma mansoni* in infants (aged < 3 years) along the Ugandan shoreline of Lake Victoria. Ann Trop Med Parasitol. 200.
76. World Health Organization. Statement- WHO Working Group on Urogenital Schistosomiasis and HIV Transmission, 1–2 October 2009. Geneva, Switzerland: World Health Organization; 2009 [cited 2017 May]. Neglected Tropical Diseases].
77. Barda B, Coulibaly JT, Hatz C, Keiser J. Ultrasonographic evaluation of urinary tract morbidity in school-aged and preschool-aged children infected with Schistosoma haematobium and its evolution after praziquantel treatment: A randomized controlled trial. PLoS Negl Trop Dis. 2017;11(2):e0005400. pmid:28222149 View ArticlePubMed/NCBIGoogle Scholar

78. Bottieau E, Clerinx J, De Vega MR, Van den Enden E, Colebunders R, Van Esbroeck M, et al. Imported Katayama fever: clinical and biological features at presentation and during treatment. Journal of Infection. 2006;52(5):339–45. pmid:16169593 View ArticlePubMed/NCBIGoogle Scholar
79. Lambertucci J. Acute schistosomiasis: clinical, diagnostic and therapeutic features. Revista do Instituto de Medicina Tropical de São Paulo. 1993;35(5):399–404. pmid:8115806 View ArticlePubMed/NCBIGoogle Scholar
80. Chen L, Liu WQ, Lei JH, Guan F, Li MJ, Song WJ, et al. Chronic Schistosoma japonicum infection reduces immune response to vaccine against hepatitis B in mice. PLoS ONE. 2012;7(12):e51512. pmid:23272112; PubMed Central PMCID: PMCPMC3522692.
81. Rabecca Tembo, Mildred Zulu, Walter Mileya, John Yabe, (2022), Prevalence and Molecular Identification of *Schistosoma haematobium* among Children in Lusaka and Siavonga Districts, Zambia.
82. Dr. S. Kayuni, (2020), Multidisciplinary studies of schistosomiasis and HIV on the shoreline of Lake Malawi: A longitudinal cohort study of male genital schistosomiasis (MGS) among fishermen in Mangochi District.
83. Allen G, (2017), Elsevier International journal of Infectious Diseases, A new global strategy for the elimination of schistosomiasis.
84. Isaiah Phyllis Munyiva, Marta Solevig Pameirim, Peter Steinmann, (2023) Infectious Diseases of Poverty BMC: epidemiology of pediatric schistosomiasis.2023.
85. Tafase Tadele, (2023), Prevalence and Determinants of *Schistosoma mansoni* Infection among Pre-School Age Children in Southern Ethiopia.
86. Kebabonye P. Gabaake, Nthabiseng A. Phaladze, Don Eliseo Lucero-Prisno, Olekae T. Thakadu, (2022) Research Article, Global Health Research and Policy
87. **Derick N.M. Osakunor**, **Mark E. J. Woolhouse, Francisca Mutapi, (2018)** Paediatric schistosomiasis: What we know and what we need to know.
88. World Health Organization. Ending the neglect to attain the Sustainable Development Goals: a road map for neglected tropical diseases 2021–2030. Geneva:

89. World Health Organization; 2020. 9. Stothard JR, Sousa-Figueiredo JC, Betson M, Bustinduy A, Reinhard-Rupp J. Schistosomiasis in African infants and preschool children: let them now be treated! Trends Parasitol. 2013
90. Nalugwa A, Nuwaha F, Tukahebwa EM, Olsen A. Schistosoma mansoniassociated morbidity among preschool-aged children along the shores of Lake Victoria in Uganda. Trop Med Infect Dis. 2017.
91. Caitlin Sheehy1* Heather Lawson2 , Emmanuel H. Andriamasy3 , Hannah J. Russell1 , Alice Reid4 , Gina U. Raderalazasoa3 , Graham Dodge, Prevalence of intestinal schistosomiasis in pre-school aged children: a pilot survey in Marolambo District, Madagascar, 2021.
92. Phyllis Munyiva Isaiah, Pediatric schistosomiasis in hard-to-reach areas and populations, 2025.
93. Caitlin Sheehy1* , Heather Lawson2 , Emmanuel H. Andriamasy3 , Hannah J. Russell1 , Alice Reid4 , Gina U. Raderalazasoa3 , Graham Dodge, Prevalence of intestinal schistosomiasis in pre-school aged children: a pilot survey in Marolambo District, Madagasca,2023.
94. Abiola Fatimah Adenowoa, Babatunji Emmanuel Oyinloyea,b, Bolajoko Idiat Ogunyinkaa, Abidemi Paul Kappoa, Impact of human schistosomiasis in sub-Saharan Africa, 2014.
95. Phyllis Munyiva Isaiah, Marta Sólveig Palmeirim, and Peter Steinmann ,2021 Epidemiology of pediatric schistosomiasis in hard-to-reach areas and populations: a scoping review .
96. World Health Organization. Schistosomiasis and soil-transmitted helminthiases: progress report, 2021. 2021. https://www.who.int/publications/i/ item/who-wer9748-621-632.
97. Gryseels B, Polman K, Clerinx J, Kestens L. Human schistosomiasis. Lancet. 2006
98. Engels D, Chitsulo L, Montresor A, Savioli L. The global epidemiological situation of schistosomiasis and new approaches to control and research. Acta Trop. 2002;82:139–46.
99. Colley DG, Fleming FM, Matendechero SH, Knopp S, Rollinson D, Utzinger J, et al. Contributions of the Schistosomiasis Consortium for Operational Research and Evaluation (SCORE) to schistosomiasis control and elimination: key fndings and

messages for future goals, thresholds, and operational research. Am J Trop Med Hyg. 2020.

100. Davis SM, Wiegand RE, Mulama F, Kareko EI, Harris R, Ochola E, et al. Morbidity associated with schistosomiasis before and after treatment in young children in Rusinga Island, western Kenya. Am J Trop Med Hyg. 2015.

101. Mafana CF, Ekpo UF, Ojo DA. Urinary schistosomiasis in preschool children in settlements around Oyan Reservoir in Ogun State, Nigeria: implications for control. Trop Med Int Health. 2003.

102. Nalugwa A, Nuwaha F, Tukahebwa EM, Olsen A. Schistosoma mansoniassociated morbidity among preschool-aged children along the shores of Lake Victoria in Uganda. Trop Med Infect Dis. 2017.

12.0. AUTHOR DECLARATIONS

I **Jairos Julius Chirwa** conceptualized and designed the study, conducted data collection, performed data analysis, and drafted the manuscript. My supervisor Dr. Mable Mutengo contributed to the supervision of the research process and critically reviewed the Manuscript for intellectual content. Dr. Paul Simusika and other authors assisted in revision of the Manuscript and red the final version of the Manuscript.

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I sign Jailos Chirwa  this 14th April,2026