

Prevalence and Risk Factors for Urinary Schistosomiasis Among School Children in Uwandani Shehia, Pemba, Zanzibar - Tanzania

Adam R. Suleiman

Department of Parasitology and Medical Entomology, Muhimbili University of Health and Allied Sciences, Tanzania

Marycelina Mubi

Department of Natural Sciences, State University of Zanzibar, Tanzania

Abdalla I Ali

Department of Natural Sciences, State University of Zanzibar, Tanzania

Chukwuma J. Okafor

Department of Pathology and Biochemistry, State University of Zanzibar, Tanzania

Paul Eze

Department of Health Policy & Administration, Pennsylvania State University, University Park

Oghenekaro Omodior (✉ oomodior@indiana.edu)

Department of Health & Wellness Design, School of Public Health, Indiana University Bloomington

<https://orcid.org/0000-0002-6918-1917>

Research Article

Keywords: urinary schistosomiasis, S. haematobium, knowledge, attitude, perception, Zanzibar

Posted Date: March 9th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-297852/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Despite repeated rounds of mass drug administration (MDA) of praziquantel, Uwandani Shehia in Pemba, Zanzibar-Tanzania, remains a hotspot of transmission of *Schistosoma haematobium*. This study was designed to determine the prevalence and risk-factors of urinary schistosomiasis among school children in Uwandani. We adopted a mixed methods approach. Data were collected using a structured questionnaire, and the filtration technique was used to detect *S. haematobium* eggs in 10 ml of urine from 300 school children. We also conducted 30 in-depth interviews with parents and teachers, 4 focus group discussions with adult community members, and 8 group discussions with the students between May & June 2017. The *S. haematobium* infection prevalence was 11%. *Schistosoma haematobium* infection prevalence was significantly higher in the age group 13-15 years, compared to the younger age groups. About 67.0% of the school children infected with *S. haematobium* had the light intensity infection, shedding fewer than or equal to 50 eggs per 10 ml of urine, while the heavy intensity of infection (>50 eggs/10 ml) was found in 33 % of infected primary school children. Results of ANOVA revealed significant differences in praziquantel uptake by age-group. There was low community knowledge of *S. haematobium* risk factors, high engagement in risky behavior and high awareness of *S. haematobium* infection symptoms. Although uptake of praziquantel is high, this did not translate to a lowering of *S. haematobium* infection prevalence among school children. Frequency of contact with open water sources – an important risk factor for *S. haematobium* infection is high in the study population. We conclude that barriers to health behavior change continue to exist, and the prevalence of urinary schistosomiasis appears to be increasing among school aged children in Uwandani Shehia, Pemba, Zanzibar-Tanzania. We suggest combining MDA praziquantel uptake programs with affordable snail control interventions for reducing urinary schistosomiasis prevalence.

Introduction

Schistosomiasis affects almost 240 million people worldwide, and more than 700 million people live in endemic areas (World Health Organization 2020). The infection is prevalent in tropical and sub-tropical areas, in poor communities without access to safe drinking water and adequate sanitation (Tchuenté et al. 2013). The most common clinical symptoms of urinary schistosomiasis include acute illness characterized by blood in the urine (haematuria), anaemia in children, pain, and difficulty in urination (dysuria). Chronic infection leads to the development of fibrosis of the bladder and ureter and kidney damage (Smyth 1990). Besides anemia, schistosomiasis if left untreated in children, can lead to stunted growth, chronic organ inflammation and death in the most serious cases. As efforts focus on morbidity control and elimination, the mainstay of the strategy recommended by World Health Organization (WHO) against urinary schistosomiasis is targeted treatment with praziquantel (World Health Organization 2020). In highly endemic areas of Tanzania, targeted treatment with praziquantel for the most at-risk groups identified through community diagnosis and schools as sentinels, have led to considerable reductions in schistosomiasis induced morbidity (Knopp et al. 2013).

Tanzania is endemic for both urinary and intestinal schistosomiasis and urinary schistosomiasis is highly endemic along the eastern and south-eastern coasts, the islands of Unguja and Pemba (Zanzibar) and the hinterland areas of Tanzania mainland (Pennance et al. 2016; Knopp et al. 2016). A survey conducted in 2014 by Schistosomiasis Consortium for Operational Research and Evaluation (SCORE), revealed an overall prevalence of *S. haematobium* of 7% for the school-aged and 4 % for adult communities in Zanzibar (Pennance et al. 2016). In Unguja Island, the finding revealed that overall urinary schistosomiasis prevalence was below 3% in adults and below 5% in school children, while in Pemba it was slightly higher, at about 6% in adults and 10% in school children. However, there are several communities in Pemba such as Uwandani that have maintained high prevalence of urinary schistosomiasis, recording up to 32% with heavy intensity in > 20 % of affected individual (Knopp et al. 2016), and school aged children remain the most at-risk group (Sokolow et al. 2016).

The continued high prevalence of the infection in Uwandani, Pemba has serious consequences on the health of the people. The cognitive ability and growth development of the young children and hence school performance may be seriously affected due to morbidity by *S. haematobium* infection (Sokolow et al. 2016). Particularly in resource limited settings, there is a need to identify the segment of population most at risk for schistosomiasis, so that adequate resources can be allocated to mitigate the negative impacts of this preventable disease. This study was designed to determine the prevalence and associated risk factors for the continuous transmission of urinary schistosomiasis among school children in Uwandani, a hotspot of schistosomiasis transmission in Zanzibar, Tanzania.

Materials And Methods

Study Area: Uwandani is located in the Pemba island district of Chake (5° 10' 0" S, 39° 47' 0" E), approximately 8km south of the city of Mombasa, in Kenya. Pemba is found along the Indian Ocean coastline as part of Zanzibar comprising four districts (Micheweni, Wete, Chake, and Mkoani) (Figure 1). These districts are subdivided into administrative units called shehias. Each shehia has one local, elected community leader called a Sheha. It is among the hotspots of urinary schistosomiasis, with high prevalence rates observed among school-aged children (Makame 2017). Uwandani shehia is comprised of small villages that are mostly surrounded by large ponds of stagnant water. These water bodies provide not only ideal conditions for recreational activities for children living in the area but also potential breeding sites for snails of the genus *Bulinus*, an intermediate host for *S. haematobium* (Marti et al. 1985). Small scale farming for food crop production, such as rice farming, growing vegetables, and fishing are the main economic activities of the people living in this area. The area experiences two annual rain seasons that are "Masika" the long rainy season which usually starts from March to June and "Vuli", the short rainy season from October to November. It is characterized by an average annual temperature in the range of 23°C and 32°C, and a total annual rainfall of about 1,900 mm. During the rainy season, the area receives a lot of rainfall which becomes the source of vast water bodies, particularly ponds which are widespread in the area. People use this source of water for their domestic and social activities.

Study design and duration: The study adopted a mixed methods approach. The first part was a descriptive cross-sectional parasitological survey involving school-aged children in Uwandani. This was followed by a qualitative inquiry involving teachers, parents, and community members which took place between May and June 2017.

Study population: The eligible subjects or participants of this study were primary school children, teachers, parents, and community members. To determine urinary schistosomiasis prevalence, school children aged 6–15 years were conveniently selected and enrolled from standard 1 to 6 from Uwandani primary school. Participants were stratified by class grades (1–6), after which we used simple random sampling to draw an equal proportion of children from each class grade.

Parasitology survey: Three-hundred school children participated in the parasitology screening for *S. haematobium*. Samples of 10 ml of urine were collected in plastic containers between 10.00am and 02.00pm, corresponding to the period of maximum excretion of eggs. All urine samples were transported to the laboratory of ZNTD-Pemba at Chake district where they were examined using the syringe filtration technique (World Health Organization 1993). Subsequently, the entire filter was microscopically examined for eggs of *S. haematobium*, and the numbers of eggs were recorded per 10 ml of urine according to WHO classification. Haematuria was determined by visual observation of urine samples.

Questionnaire administration. Following parental, school principal, and child consent, we used questionnaire items to collect student demographic information and data on school-based praziquantel administration. To determine reliability, questionnaires were first prepared in English, translated into Kiswahili, the main language spoken in the area and back-translated into English (Brislin 1970).

Assessments: Overall urinary schistosomiasis (*S. haematobium* infection) prevalence was measured by the finding of at least one *S. haematobium* egg in the urine sample on microscopic examination. *Dysuria* was assessed as a binary variable, based on study participants self-reported experience of feeling pain during urination (1 = dysuria absent, or 2 = dysuria present). *Praziquantel uptake* was recorded as a count variable, defined as the self-reported frequency of uptake of medication to kill parasites during previous mass drug administrations (MDA). *Infection intensity* was defined as light (1-50), and heavy (>50), based on the number of eggs per 10-ml of urine recovered on laboratory examination (Hotez et al. 2006). Class grade was assessed in 6 categories (grade 1 through grade 6), based on current class in school. Gender was assessed as binary (male and female). Three age-groups in years were recorded (6-9, 10-12, and 13-15).

Qualitative study: Purposive sampling was used to identify eligible study participants among primary school children, teachers, parents, and community members for the qualitative study. School-aged children in grades from standard 2 to standard 6 were recruited with the collaboration of the headteacher and staff from Zanzibar Neglected Tropical Diseases (ZNTD). Individual teachers were also recruited from the same public primary school, while parents and community members were mobilized through their local leaders.

The qualitative inquiry was carried out through 8 Group discussions (GD), 30 In-depth interviews (IDIs) with teachers and parents, 4 Focus group discussions (FGDs) with community members, and field observation checklist. School children were asked through group discussions using a simple topic guide about their knowledge and perceptions associated with transmitting, having, treating, and preventing urinary schistosomiasis. The discussion took place in the classroom setting and included 6–8 children of the same sex, facilitated by a research assistant. An audio recorder was used and note taking was done to record the discussions.

An interview guide was used to assess knowledge and perception of schistosomiasis transmission, specific risky behaviors, treatment, and care-seeking pathways along with control measures. Data were collected until a saturation point was reached, and no further coding was feasible (Fusch and Ness 2015). All interviews were conducted in Kiswahili, using an audio recorder and note taking. The interview took place in the local setting, with school teachers being interviewed at the local school while for parents the meetings took place in their home in the community setting.

The content of each FGD and IDI were then transcribed, translated into English, and analysed based on a modified grounded theory approach (Hallberg 2006). A checklist was used to capture critical observation of human water contact sites which could potentially act as suitable environments for transmission of *S. haematobium* infection, and risky behaviors for acquiring the infection.

Ethical Consideration: Ethical approval to conduct the study was obtained from the Muhimbili University of Health and Allied Sciences Research Ethics Committee. The study also received additional ethical approval from the Zanzibar Medical Research Ethics Committee in Zanzibar, United Republic of Tanzania (*Protocol no ST/0002/May/2017*). District Commissioner, Education district officer, and Shehia leaders were notified about the study. All participants provided written informed consent.

Data management and Statistical analysis: We used frequency distribution (percentage and counts) to describe prevalence of *S. haematobium*, intensity of infection, participants age group & gender. We used mean and standard deviation to describe praziquantel uptake. We used chi-square cross tabulation to test the hypotheses of independence between *S. haematobium* prevalence and infection intensity respectively, by class grades, gender, age-group and praziquantel uptake. We used independent samples t-test to test for the difference in the mean praziquantel uptake across gender (male, female), while ANOVA was used to test for mean praziquantel uptake across age-groups (6-9, 10-12, 13-15). Data from the quantitative survey were entered and analysed using SPSS version 20 computer software. Map of study area was created using RStudio, Version 1.3.1056.

For qualitative data, descriptive thematic analysis was applied using a modified grounded theory coding approach, and emergent themes were analysed using the Health belief model (Rosenstock 1974). These emergent themes include community knowledge and perceptions, recognition of symptoms, and risky behaviors.

Results

School children ranged in age from 6 –15 years, with a mean(SD) age of 10.4(2.34) years. There were more children (42.7%, n = 128) in the age-group 10-12 years than in the 6-9 (36%, n = 108) and 13-15 (21.3%, n = 64) age-groups respectively. Fifty-two percent (n = 157) of school children were females, compared to forty-eight percent (n = 143) that were males.

Overall *S. haematobium* infection prevalence: The overall *S. haematobium* infection prevalence was 11% (n=33). In chi-square crosstabulation tests, we found significant difference in infection prevalence by age-group χ^2 (2, n = 300) 12.73, p = 0.002. Overall *S. haematobium* infection prevalence was significantly higher (42.4 %, n = 14) in the age-group 13-15 years, compared to the younger age-groups (Table 1). No other statistically significant differences in overall *S. haematobium* infection prevalence was observed.

Praziquantel uptake (MDA): Ninety-six percent of school children self-reported receiving at least one dose of praziquantel in a previous MDA. Independent sample t-test found no statistically significant difference in mean praziquantel uptake between males (Mean±SD = 2.73±1.17) and females (Mean±SD = 2.71±1.26), t(298) = 0.126, p = 0.900. Results of one-way between-groups ANOVA revealed statistically significant differences in mean scores between age-groups: F(2, 297) = 62.57, p < 0.001. Post-hoc comparisons using the Tukey HSD, indicated that the mean praziquantel uptake for the 6-9 years age-group (Mean±SD = 1.87±0.66) is significantly different from the 10-12 years age-group (Mean±SD = 3.02±1.21) and 13-15 years age-group (Mean±SD = 3.52±1.11) respectively. The mean praziquantel uptake also differed significantly between the 10-12 years age-group and 13-15 years age-group.

Intensity of *S. haematobium* infection: About sixty-seven percent (n = 22) of the school children infected with *S. haematobium* had the light intensity infection, shedding less than or equal to 50 eggs per 10 ml of urine, while the heavy intensity infection (>50 eggs/10 ml) was found in 33 % (n = 11) of infected primary school children. In chi-square crosstabulation, we found no statistically significant differences in intensity of infection across age-groups, class grades, and gender (Table 2).

Qualitative study results

Knowledge and perceptions of schistosomiasis transmission: Analysis of qualitative data collected through GD, FGD, & IDI revealed varying levels of knowledge of urinary schistosomiasis risk factors. We found that infection with *S. haematobium* (urinary schistosomiasis) was locally referred to as “*kichocho*”. The majority of community members viewed schistosomiasis as a disease-related only to river, dirty and stagnant water. They mentioned swimming in the river, drinking river water and urination in the ponds as means of contracting and transmitting the disease. Some community members were able to identify snails, stagnant water, and poor sanitation as either causative agents or contributors in the transmission of the disease. However, there were misperceptions of causative agents and disease transmission route. For example, in addition to drinking or wading in contaminated water, masturbation was also perceived to be a cause of urinary schistosomiasis ...

“it is a disease which is found in the river (ponds) and you know what is in the river? Some bacteria are known as Schistosoma or bilharzia is that right? Or am I wrong? And this one is transmitted between person and snail (konokono) that is responsible to cause the disease which we are talking about” (Female teacher IDI).

... “it is a liver disease caused by snails (konokono) and people can get this through urination, drinking and swallowing water in the ponds” (Young adult FGD).

School children had a mix of correct and incorrect knowledge of urinary schistosomiasis and associated risk factors. They perceived urinary schistosomiasis as a river-related disease in which someone can be infected through urination or swimming in the river. However, they identified snails, dirty water, leeches, blood-sucking worms, and urination as part of the schistosomiasis transmission cycle. A young girl said:

“You can get kichocho by being bitten by worms while swimming in the river or ponds or playing in the dirty water”. Another boy said thus ... “someone can get kichocho during swimming in the river which has been urinated by someone else who releases some organism there” (GD).

Symptoms of schistosomiasis: In general, many community members identified symptoms typically associated with urinary schistosomiasis to include blood in the urine (haematuria), feeling pain during urination, fever, general malaise, headache, dizziness, irritation and cognitive impairment of the children during classroom situation ...*“In our place here we perceive kichocho as a disease which causes the infected person to experience fever and urination of blood at the end”* (FGD). One primary school teacher reported; ...*“sometimes students come to me and complain that they get pain during urination accompanied by blood at the end”* (Parent IDI).

...“symptoms of kichocho normally are fever, dizziness, and poor performance of the student as a result of prolonged illness..” Female teacher (IDI). According to several respondents, signs are the same for both boys and girls.

Specific risky behaviors of children: The results of qualitative analysis revealed that wading in ponds and rivers (open fresh contaminated water bodies) were major risk behaviors for urinary schistosomiasis. In this regard, school aged children, young adult fishermen, and people living very close to the ponds were seen to engage in this behavior the most... *“We have our tradition here of fishing small fresh fish like catfish (kambare) and tilapia (perege). To put emphasis on my statement, you can go right there by yourself for survey in the ponds, you will surely find children there, waiting and keeping their traps for fishing”* Male teacher (IDI).

In explaining this risk behavior among school children, absence of playgrounds or other alternatives were not considered as responsible for school children spending time playing in open fresh contaminated water bodies.

... “In our place here, we have been conducting fishing activities as a tradition and this is why you can find many children particularly boys do the same. They just copied from their elders and fathers in fishing in

local water ponds for freshwater fish. This is the main reason why they don't play far from the ponds and other water related activities, they just do for fun and learning swimming technique." Male teacher (IDI).

Additionally, we found that perceptions of the parents, was part responsible for this risk behavior among school children ... *"Sometimes, it is their parents who tell and order their children to go and finish all their domestic water related activities at the rivers (ponds) for believing that water from the river is cleaner than tap or well water"* Female teacher (IDI).

Finally, we found that for the most part, evaluations of the socio-economic benefits of spending time in the river and minimizations of the health risks, increased the likelihood of people, especially children engaging in the identified risky behavior ... *"they have to go there because of the benefits they get there although they understand very well the risks, they do not have another means like fishing to make ends meet"* Adult male (FGD).

Discussion

The prevalence of urinary schistosomiasis observed in this study (11%) was higher than previously reported (Knopp et al. 2013), suggesting that infection prevalence might be increasing in this area among school aged children. Similar studies have reported a prevalence of 10% in Malawi (Kapito-Tembo et al. 2009), and 14% in Senegal (Chipeta, Ngwira, and Kazembe 2013). However, studies in various parts of Cameroon found significantly higher prevalence among children in different age groups, based on proximity to open water sources (Ntonifor, Mbunkur, and Ndaleh 2012; Njunda et al. 2017). Anecdotally, while males were more likely to be exposed to infection sources such as rivers and dams, we found no statistically significant differences in infection prevalence based on gender, although Knopp et al. (2013) reported higher prevalence among males in the same study area nearly a decade earlier. Previous studies across different regions in sub-saharan African have reported mixed results (Senghor et al. 2016; Chipeta, Ngwira, and Kazembe 2013) .

This study found very high self-reported praziquantel uptake (97%). A previous study among school aged children in the same region reported uptake at 87% (Knopp et al. 2016). Other studies have reported different praziquantel uptake results (Tuhebwe et al. 2015). We found no significant association between mean praziquantel uptake and prevalence of *S. haematobium* infection, intensity of infection and gender respectively. However, we found that mean praziquantel uptake significantly differed by age group, increasing as age group increases. Previous studies have reported significant association between increasing praziquantel uptake during MDAs and reduced infection prevalence (Senghor et al. 2016). Since, MDA program is repeated at defined intervals in a year, as a result of the inability of the individual host to develop fully protective immunity to reinfection, individual compliance to these repeated rounds of MDA can have a significant impact on parasite transmission (Tuhebwe et al. 2015). This is particularly not surprising because previous multi-country studies have suggested that the most effective approaches for reducing schistosomiasis prevalence are those that combine MDA programs with affordable snail control interventions (Sokolow et al. 2016). So, while cross-sectional studies may find association

between praziquantel intake and reduced infection prevalence, effectiveness of MDAs in reducing infection prevalence will depend on a combination of factors including reducing incidence of *S. haematobium* infections through vector control programs, and praziquantel uptake during MDA (Knopp et al. 2013; Sokolow et al. 2016). We found statistically significant age group differences in praziquantel uptake, suggesting that as children grow older, they have more opportunities to participate in MDA campaigns. This is particularly applicable whether MDA takes place at fixed sites or during home-to-home visits, which is the practice at most of these locations.

We found that more children had the light intensity infection, compared to heavy intensity infection. These results are in agreement with a previous study in the same region (Knopp et al. 2013). Our results also showed that intensity of infection was independent of gender, age-group and class grades. Previous studies have reported high intensity and prevalence among school children based on sample size, frequency of contact with water and fishing (Chipeta, Ngwira, and Kazembe 2013). Our finding of no association may be a reflection of the sample size, frequency of contact with infested water and low prevalence reported in this study compared to other studies that reported significant differences in intensity of infection by demographic characteristics of study participants (Chipeta, Ngwira, and Kazembe 2013; Senghor et al. 2016).

Qualitative aspects

We found that while most of the participants perceived *S. haematobium* as a water-borne disease, there were misconceptions of the causes, transmission route, and prevention measures. For example, drinking contaminated water, dirty water, and masturbation were perceived to be the cause of the disease, and their avoidance was perceived as a means to get rid of the infection. Our results also revealed that most school aged children and non-school children engaged in the rice fields hunting for little birds, exposed themselves to open contaminated water ponds for fishing, swimming and playing, with little understanding of the adverse health effects as well as the route of transmission of *S. haematobium*. This was in line with a study in western Kenya where community members with little knowledge and poor attitude tended to defecate and engage in other activities in open contaminated waters of Lake Victoria (Musuva et al. 2014). On this basis, we conclude that community knowledge about *S. haematobium* was low. This was similar to the findings reported from Tanzania (Knopp et al. 2013), Ethiopia (Legesse et al. 2009) and Kenya (Musuva et al. 2014) where a lack of understanding and misconceptions of routes of transmission and sources of infection were common. Community awareness, misconceptions and stigma associated with the transmission of *S. haematobium* has multiple public health implications including likelihood of adopting recommended personal protective behaviors, and treatment seeking behaviors (Tuhebwe et al. 2015). Lack of knowledge also poses a barrier to *S. haematobium* infection control and elimination strategies.

We observed that community members had high awareness of the symptoms of *S. haematobium* infection, as they were able to identify a common symptom of *S. haematobium* infection – presence of

blood in urine. Particularly, in remote areas and resource limited settings, the ability to identify early symptoms of infection is critical since individuals are then able to promptly seek care and treatment, thereby avoiding secondary complications. Our findings are in contrast to those from Cameroon, where residents of rural areas related haematuria to excessive exposure to sunlight and sexual intercourse thereby dismissing medical treatment in local hospitals as a result of such beliefs (Robert, Bouvier, and Rougemont 1989).

Our study findings reveal that most school aged children in Uwandani engaged in high risk behaviors for *S. haematobium* infection. Several children reported swimming, playing, fishing, and exposing themselves in open contaminated water. Community members perceived the quality of contaminated freshwater ponds as the best option to clean their domestic utensils than tap water or water from dug wells. Moreover, many participants claimed that a lack of other alternatives and dependency on water for fishing and farming daily, are the main reasons to be exposed to contaminated fresh ponds. These findings further support our assessment of low knowledge of *S. haematobium* among study participants. Previous studies reported similar behaviors in communities where low knowledge of *S. haematobium* was prevalent (Onyeneho et al. 2010; Kloos 1995).

According to the health belief model, perceived seriousness and perceived susceptibility to a negative health outcome (disease) are strong predictors of the likelihood of adopting recommended health behaviors (Rosenstock 1974). In this regard, the likelihood of taking recommended action against the transmission of *S. haematobium* would be directly determined by beliefs about the threat of the disease (i.e. perceived severity and perceived susceptibility). Given the observed low knowledge and associated high risk behaviors, among school age children, school-based awareness or interventions involving community leaders, could be useful in addressing perceived barriers to health behavior, risk reduction behavior, and ultimately a reduction in the threat of urinary schistosomiasis.

Study Limitations

The cross sectional nature of the study design, indicates that our results capture only a snapshot in time and may not generally represent, prevalence and risk factors for *S. haematobium* infection among Uwandani school children. Additionally, given that study participants were recruited only from a public government school, the findings may not be generalizable to all school children including those from private schools or elsewhere beyond the study area, particularly if the excluded population are significantly different in some respect from our study participants. A broader sampling frame is required to make the results more generalizable. Some of the data were self-reported, and therefore prone to recall bias, social desirability and other unmeasured biases, which may lead to over- or under- inflation of certain responses. Finally, data were collected in Kiswahili, while analysis was conducted in English, and hence some important information may have been missed or ideas misinterpreted.

Despite these limitations, our study findings have important health promotion implications. This study determined that compared to previous studies, urinary schistosomiasis might be increasing among

school children in the study region. Although mean praziquantel uptake significantly increased as age increases, this did not directly translate to lowering of prevalence of *S. haematobium*, as we also noted a significantly higher prevalence of infection with *S. haematobium* in children ≥ 13 years of age compared to children aged < 13 years. Qualitative analysis revealed that there was a generally low knowledge of *S. haematobium* and high risk behavior in the community. We therefore recommend that efforts should be made to raise awareness of *S. haematobium* infection risk factors in the community. Public health agencies and policy makers should collaborate with community members to create recreational spaces and avenues that will reduce exposure of school aged children to open water sources of infection with *S. haematobium*. Finally, combining MDA of praziquantel programs with affordable snail control interventions is suggested for reducing urinary schistosomiasis prevalence among school aged children in Uwandani Shehia, Pemba, Zanzibar-Tanzania.

Declarations

ACKNOWLEDGMENT

We would like to express our appreciation to Dr. Billy Ngasala, head of the department of Medical parasitology and Entomology for his encouragement and steadfast support for this work. We also acknowledge the contribution made by all medical laboratory technicians at ZNTD-Pemba Chake Chake district who assisted with the collection of field data and processing of specimens. Finally, the school-aged children, teachers, and community members at the Uwandani area, the coordinator of schistosomiasis control center Dr. Saleh Juma, for his excellent support of this study.

Compliance with Ethical Standards

Conflict of interest: The authors have no actual or potential conflicts of interest to declare.

References

1. Brislin, Richard W. 1970. 'Back-translation for cross-cultural research', *Journal of cross-cultural psychology*, 1: 185-216.
2. Chipeta, Michael G, Bagrey Ngwira, and Lawrence N Kazembe. 2013. 'Analysis of schistosomiasis haematobium infection prevalence and intensity in Chikhwawa, Malawi: an application of a two part model', *PLoS Negl Trop Dis*, 7: e2131.
3. Fusch, Patricia I, and Lawrence R Ness. 2015. 'Are we there yet? Data saturation in qualitative research', *The qualitative report*, 20: 1408.
4. Hallberg, Lillemor RM. 2006. 'The "core category" of grounded theory: Making constant comparisons', *International journal of qualitative studies on health and well-being*, 1: 141-48.
5. Hotez, Peter J, Donald AP Bundy, Kathleen Beegle, Simon Brooker, Lesley Drake, Nilanthi de Silva, Antonio Montresor, Dirk Engels, Matthew Jukes, and Lester Chitsulo. 2006. 'Helminth infections: soil-

- transmitted helminth infections and schistosomiasis', *Disease Control Priorities in Developing Countries. 2nd edition.*
6. Kapito-Tembo, Atupele P, Victor Mwapasa, Steven R Meshnick, Young Samanyika, Dan Banda, Cameron Bowie, and Sarah Radke. 2009. 'Prevalence distribution and risk factors for Schistosoma hematobium infection among school children in Blantyre, Malawi', *PLoS Negl Trop Dis*, 3: e361.
 7. Kloos, Helmut. 1995. 'Human behavior, health education and schistosomiasis control: a review', *Social science & medicine*, 40: 1497-511.
 8. Knopp, Stefanie, Bobbie Person, Shaali M Ame, Said M Ali, Juma Muhsin, Saleh Juma, Iddi S Khamis, Muriel Rabone, Lynsey Blair, and Alan Fenwick. 2016. 'Praziquantel coverage in schools and communities targeted for the elimination of urogenital schistosomiasis in Zanzibar: a cross-sectional survey', *Parasites & vectors*, 9: 5.
 9. Knopp, Stefanie, Bobbie Person, Shaali M Ame, Khalfan A Mohammed, Said M Ali, I Simba Khamis, Muriel Rabone, Fiona Allan, Anouk Gouvras, and Lynsey Blair. 2013. 'Elimination of schistosomiasis transmission in Zanzibar: baseline findings before the onset of a randomized intervention trial', *PLoS Negl Trop Dis*, 7: e2474.
 10. Legesse, Mengistu, Chelsea R Jones, Sarita K Singh, Berhanu Erko, and Yalemtehay Mekonnen. 2009. 'Community's awareness about intestinal schistosomiasis and the prevalence of infection in two endemic localities of Ethiopia', *Ethiopian Journal of Health Sciences*, 19.
 11. Makame, Suleiman Amani. 2017. 'Factors influencing performance of screening methods for urinary schistosomiasis among school children in Uwandani Pemba, Zanzibar-Tanzania, 2017', Muhimbili University of Health and Allied Sciences.
 12. Marti, HP, M Tanner, AA Degremont, and TA Freyvogel. 1985. 'Studies on the ecology of Bulinus globosus, the intermediate host of Schistosoma haematobium in the Ifakara area, Tanzania', *Acta tropica*, 42: 171-87.
 13. Musuva, Rosemary M, Alphonse Awiti, Martin Omedo, Michael Ogutu, W Evan Secor, Susan P Montgomery, Jane Alaii, and Pauline NM Mwinzi. 2014. 'Community knowledge, attitudes and practices on schistosomiasis in western Kenya-the SCORE Project', *The American journal of tropical medicine and hygiene*, 90: 646-52.
 14. Njunda, Anna Longdoh, Emmanuel Ngala Ndzi, Jules Clement Nguedia Assob, Henri-Lucien Fawmno Kamga, and Emmanuel Tebit Kwenti. 2017. 'Prevalence and factors associated with urogenital schistosomiasis among primary school children in barrage, Magba sub-division of Cameroon', *BMC public health*, 17: 1-9.
 15. Ntonifor, HN, GN Mbunkur, and NW Ndaleh. 2012. 'Epidemiological Survey of Urinary Schistosomiasis in some Primary Schools in a new focus behind Mount Cameroon, South West Region, Cameroon', *East African Medical Journal*, 89: 82-88.
 16. Onyeneho, Nkechi G, Paul Yinkore, John Egwuage, and Emmanuel Chukwudirim Emukah. 2010. 'Perceptions, attitudes and practices on schistosomiasis in Delta State, Nigeria', *Tanzania Journal of Health Research*, 12: 278-82.

17. Pennance, Tom, Bobbie Person, Mtumweni Ali Muhsin, Alipo Naim Khamis, Juma Muhsin, Iddi Simba Khamis, Khalfan Abdallah Mohammed, Fatma Kabole, David Rollinson, and Stefanie Knopp. 2016. 'Urogenital schistosomiasis transmission on Unguja Island, Zanzibar: characterisation of persistent hot-spots', *Parasites & vectors*, 9: 1-13.
18. Robert, CF, S Bouvier, and A Rougemont. 1989. "Epidemiology, anthropology and health education." In *World health forum 1989; 10 (3/4): 355-364*.
19. Rosenstock, Irwin M. 1974. 'Historical origins of the health belief model', *Health education monographs*, 2: 328-35.
20. Senghor, Bruno, Omar Talla Diaw, Souleymane Doucoure, Mouhamadane Seye, Adiouma Diallo, Idrissa Talla, Cheikh T Ba, and Cheikh Sokhna. 2016. 'Impact of annual praziquantel treatment on urogenital schistosomiasis in a seasonal transmission focus in Central Senegal', *PLoS neglected tropical diseases*, 10: e0004557.
21. Smyth, JD. 1990. "Foundations of parasitology (4th edn): GD Schmidt and LS Roberts, Williams and Wilkins, 1989.£ 33.75 (vii+ 750 pages) ISBN 0 8016 5039 9." In.: Elsevier Current Trends.
22. Sokolow, Susanne H, Chelsea L Wood, Isabel J Jones, Scott J Swartz, Melina Lopez, Michael H Hsieh, Kevin D Lafferty, Armand M Kuris, Chloe Rickards, and Giulio A De Leo. 2016. 'Global assessment of schistosomiasis control over the past century shows targeting the snail intermediate host works best', *PLoS neglected tropical diseases*, 10: e0004794.
23. Tchuenté, Louis-Albert Tchuem, Calvine Dongmo Noumedem, Pierre Ngassam, Christian Mérimé Kenfack, Nestor Feussom Gipwe, Esther Dankoni, Ann Tarini, and Yaobi Zhang. 2013. 'Mapping of schistosomiasis and soil-transmitted helminthiasis in the regions of Littoral, North-West, South and South-West Cameroon and recommendations for treatment', *BMC Infectious Diseases*, 13: 602.
24. Tuhebwe, Doreen, James Bagonza, Elizabeth Ekirapa Kiracho, Adoke Yeka, Alison M Elliott, and Fred Nuwaha. 2015. 'Uptake of mass drug administration programme for schistosomiasis control in Koome Islands, Central Uganda', *PloS one*, 10: e0123673.
25. World Health Organization. 1993. *The control of schistosomiasis: second report of the WHO Expert Committee [meeting held in Geneva from 8-15 November 1991]* (World Health Organization).
26. ——. 2020. 'Schistosomiasis', Accessed September 08. <https://www.who.int/en/news-room/fact-sheets/detail/schistosomiasis>.

Tables

Table 1: Overall *S. haematobium* infection prevalence among Nwadani school children by age-group, class grade, and gender.

	Total N = 300	Not infected (n = 267)	Infected (n =33)	p-value
Age-group				
- 6 – 9 years	107 (35.7%)	94 (35.2%)	13 (39.4%)	0.002*
- 10 – 12 years	128 (42.6%)	122 (45.7%)	6 (18.2%)	
- 13 – 15 years	65 (21.7%)	51 (19.1%)	14 (42.4%)	
Class grade				
- 1	52 (17.3%)	45 (16.9%)	7 (21.2%)	0.294
- 2	69 (23.0%)	64 (24.0%)	5 (15.2%)	
- 3	55 (18.3%)	52 (19.5%)	3 (9.1%)	
- 4	61 (20.3%)	53 (19.9%)	8 (24.2%)	
- 5	34 (11.3%)	30 (11.2%)	4 (12.1%)	
- 6	29 (9.7%)	23 (8.6%)	6 (18.2%)	
Gender				
- Female	156 (52.0%)	139 (52.1%)	17 (51.5%)	1.000
- Males	144 (48%)	128 (47.9%)	16 (48.5%)	

*significant at $p < 0.05$

Table 2. Mean praziquantel uptake by *S. haematobium* infection prevalence, intensity of infection, gender, and age-group

	N	Mean	Standard deviation	p-value
Overall S. haematobium infection prevalence				
- Infected	33	2.82	1.18	0.618
- Not infected	267	2.71	1.22	
Intensity of infection				
- Light intensity (≤ 50 eggs/10ml urine)	22	3.00	1.2	0.213
- Heavy intensity (> 50 eggs/10ml urine)	11	2.45	1.1	
Gender				
- Female	156	2.71	1.265	0.900
- Male	144	2.73	1.166	
Age-group				
- 6 – 9 years	107	1.87	0.660	<0.001*
- 10 – 12 years	128	3.02	1.213	
- 13 – 15 years	65	3.52	1.105	
*significant at $p < 0.05$				

Table 2. Intensity of S. haematobium infection among Nwadani school children by class grade, gender, and age-group.

	Total <i>S. haematobium</i> infection prevalence (n = 33)	Light intensity <i>S. haematobium</i> infection (n = 22)	Heavy intensity <i>S. haematobium</i> infection (n = 11)	p-value*
Age-group				
- 6 – 9 years	13 (39.4%)	7 (53.8%)	6 (46.2%)	0.136
- 10 – 12 years	6 (18.2%)	6 (100.0%)	0 (0.0%)	
- 13 – 15 years	14 (42.4%)	9 (64.3%)	5 (35.7%)	
Class grade				
- Class 1	7 (21.2%)	4 (57.1%)	3 (42.9%)	0.933
- Class 2	5 (15.2%)	3 (60.0%)	2 (40.0%)	
- Class 3	3 (9.1%)	2 (66.7%)	1 (33.3%)	
- Class 4	8 (24.2%)	5 (62.5%)	3 (37.5%)	
- Class 5	4 (12.1%)	3 (75.0%)	1 (25.0%)	
- Class 6	6 (18.2%)	5 (83.3%)	1 (16.7%)	
Gender				
- Female	17 (51.5%)	11 (64.7%)	6 (35.3%)	1.000
- Males	16 (48.5%)	11 (68.7%)	5 (31.3%)	

*significant at $p < 0.05$

Figures

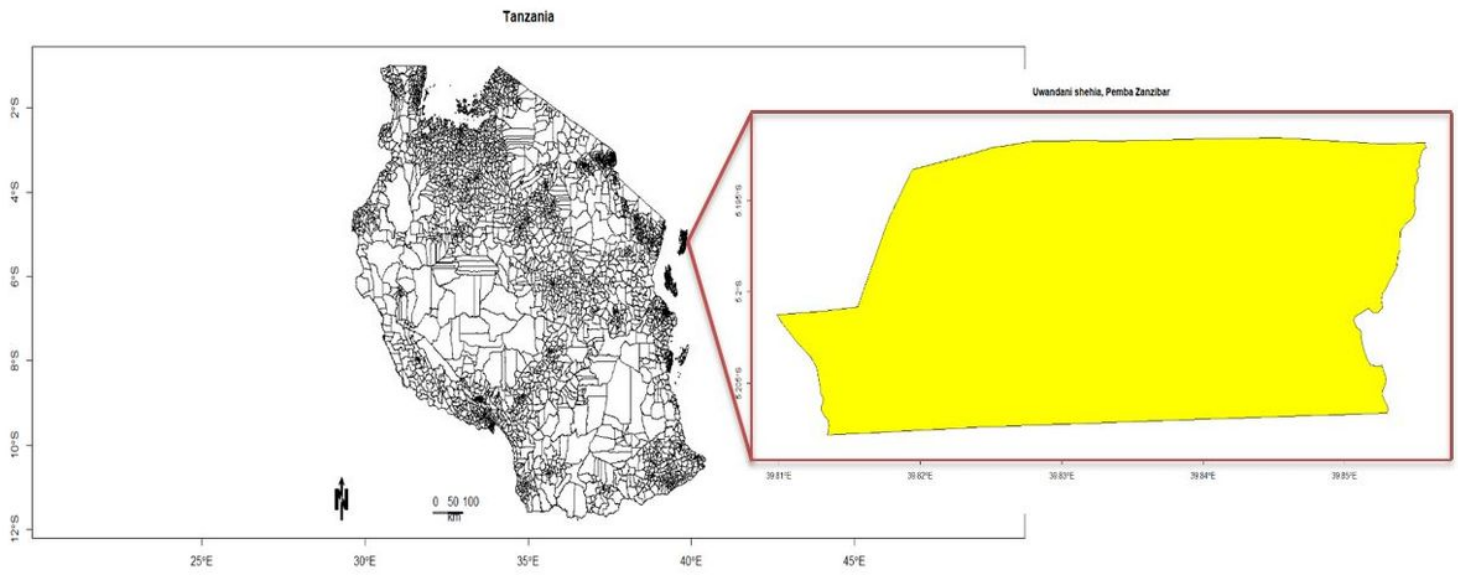


Figure 1

Map of Study area - Uwandani shehia in Pemba lake district of Zanzibar-Tanzania