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

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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. Demographic and school-based praziquantel administration 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. Sixty-seven percent 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.

Keywords: Attitude; Knowledge; Perception; *S. haematobium*; Urinary schistosomiasis; Zanzibar

Introduction

Schistosomiasis affects almost 240 million people worldwide, and more than 700 million people live in endemic areas [1]. The infection is prevalent in tropical and sub-tropical areas, in poor communities without access to safe drinking water and adequate sanitation [2]. The most common clinical symptoms of urinary schistosomiasis include acute illness characterized by blood in the urine (haematuria), anaemia in children, pain, and painful urination (dysuria). Chronic infection leads to the development of fibrosis of the bladder and ureter and kidney damage [3]. 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 [1] against urinary schistosomiasis is targeted treatment with praziquantel [1]. 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 [4].

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 [5,6]. 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 [5]. 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 [6], and school aged children remain the most at-risk group [7].

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 [7]. 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 [8]. 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* [9]. 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.

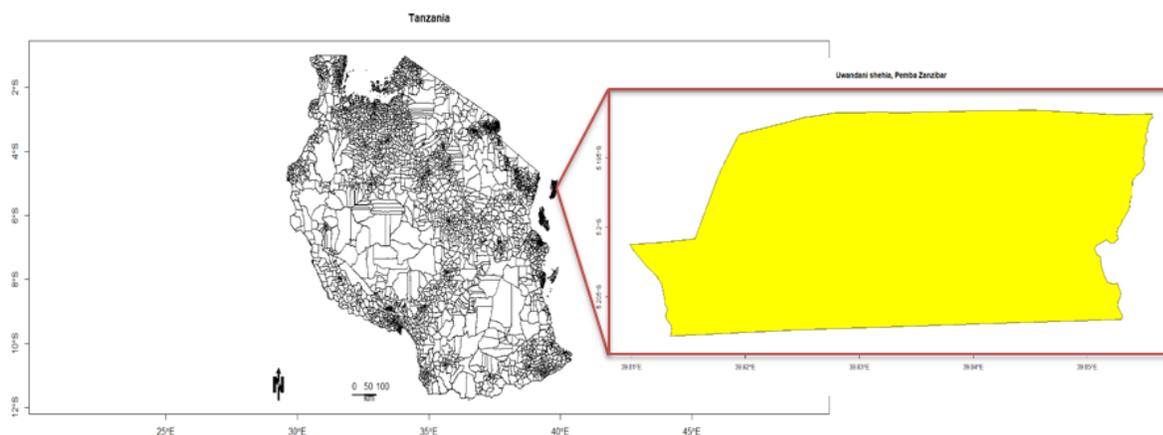


Figure 1: Map of Urogenital schistosomiasis among School children study area - Uwandani shehia in Pemba lake district of Zanzibar-Tanzania.

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.

Sample size determination: Based on a 2% margin of error and 95% confidence level, and approximate population of students in the Uwandani shehia administrative unit (3000), we used the Qualtrics sample size calculator to arrive at a sample size of 270 participants. [10]. The three hundred students used in this study was therefore adequate.

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 [1]. 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. Macrohaematuria was determined by visual observation of urine samples.

Questionnaire administration. After parents, school principal, and child signed the informed consent sheet, 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 [11].

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 [12]. 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 [13]. 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 [14]. 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.

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. 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 [15]. 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 X2 (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.

	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
- Males	144 (48%)	128 (47.9%)	16 (48.5%)	

*significant at p < 0.05

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

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 (Table 2). 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.

	N	Mean	Standard deviation	p-value
Overall <i>S. haematobium</i> 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	1.2	0.213
- Heavy intensity (>50 eggs/10ml urine)				
	11	2.45	1.1	
Gender				
- Female	156	2.71	1.265	0.9
- Male	144	2.73	1.166	
Age-group				
- 6 - 9 years	107	1.87	0.66	<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: Mean praziquantel uptake by *S. haematobium* infection prevalence, intensity of infection, gender, and 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 3).

	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
- Males	16 (48.5%)	11 (68.7%)	5 (31.3%)	

Table 3: Intensity of *S. haematobium* infection among Nwadani school children by class grade, gender, and age-group.

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 [4], suggesting that infection prevalence might be increasing in this area among school aged children. Similar studies have reported a prevalence of 10% in Malawi [16], and 14% in Senegal [17]. However, studies in various parts of Cameroon found significantly higher prevalence among children in different age groups, based on proximity to open water sources [18,19]. 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 [4] 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 [17,20]. It is quite likely that the a combination of factors including children playing in open water sources, might be responsible for the slightly higher prevalence of urinary schistosomiasis observed in this study.

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% [6]. Other studies have reported different praziquantel uptake results [21]. 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 [20]. 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 [21]. 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 [7]. 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 [4,7]. 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 [4]. 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 [17]. 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 [17,20]

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 [22]. On this basis, we conclude that community knowledge about *S. haematobium* was low. This was similar to the findings reported from Tanzania [4], Ethiopia [23] and Kenya [22] 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 [21]. 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 [24].

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 [25].

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 [15]. 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.

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. In conclusion, future studies should investigate whether changing health behaviors and risk perceptions are among school children and their families are impacting the prevalence of urinary schistosomiasis in the Uwandani Shehia, Pemba, Zanzibar-Tanzania.

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Conflict of Interest

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

Declarations

Not applicable

Funding Information

Not applicable

Ethics Approval

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.

Consent to Participate

All participants provided written informed consent.

Consent for Publication

All authors give their consent for publication
Availability of data and material (data transparency)
The data are not publicly available, but can be provided on request

Code Availability

Not applicable

Authors contributions

Adam R. Suleiman - conceptualization, data collection, manuscript writing
Marycelina Mubi - conceptualization, data collection, proof-reading, funding source
Abdalla I Ali - data collection, manuscript writing, proof-reading
Chukwuma J. Okafor - conceptualization, manuscript writing, proof-reading
Paul Eze - Data analysis, manuscript writing
Oghenekaro Omodior - Data analysis, manuscript writing, proof-reading

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