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Original article

Prevalence of urogenital schistosomiasis and risk factors for transmission among primary school children in an endemic urban area of Kinondoni municipality in Dar es Salaam, Tanzania

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PC: Preventive Chemotherapy
MDA: Mass Drug Administration
SPSS: Statistical Package for the Social Sciences
WSH: Water, Sanitation, and Hygiene

ABSTRACT

Background: Schistosomiasis is among the neglected tropical diseases that cause significant morbidity and mortality among the vulnerable population including school-aged children. This study aimed to determine the prevalence of urogenital schistosomiasis and risk factors for transmission among primary school children in an endemic urban area of Kinondoni municipality in Dar es Salaam, Tanzania. **Methods:** A quantitative cross-sectional study was conducted between June and August 2020. A total of 250 urine samples were collected from primary school children, examined for haematuria using urinalysis test strips, and *Schistosoma haematobium (S.haematobium)* infection and intensity using the urine filtration technique. A structured questionnaire was used to collect information on water, sanitation, and hygiene risk factors that could influence the transmission of urogenital schistosomiasis. **Results:** Out of 250 primary school children recruited, 13(5.2%) had haematuria, 3(1.2%) had *S.haematobium* ova, and all were light-intensity infections. Among the assessed risk factors, the following were significantly associated with the transmission of urogenital schistosomiasis; type of latrine used at home ($p=0.044$), frequency of swimming ($p=0.030$), the children who never swallowed praziquantel ($p<0.00$), experienced side effects ($p<0.00$), type of side effects experienced ($p=0.037$), and reasons for not taking praziquantel in the last round of mass drug administration ($p=0.007$). **Conclusion:** The low prevalence of urogenital schistosomiasis indicates the ongoing transmission of the disease among primary school children. Frequency of swimming, type of latrines used at home, and non-uptake of praziquantel are the risk factors for the infection among primary school children.

Introduction

Urogenital schistosomiasis is a disease of public health concern. The majority of urogenital schistosomiasis cases occurred to people living in Sub-Saharan Africa. It's estimated that 436 million people are at risk of acquiring urogenital schistosomiasis in Sub-Saharan Africa, and 112 million people are already infected with *Schistosoma haematobium* (*S.haematobium*) [1]. Urogenital schistosomiasis is responsible for the morbidity and mortality among the vulnerable population, whereby 103 million people had haematuria and dysuria, 100 million people had bladder morbidity, 19 million had kidney problems, and 0.162 mortality due to bladder and kidney cancers per year [1] .

Tanzania is among urinary schistosomiasis endemic countries with different levels of

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endemicity across the country [2]. Urinary schistosomiasis is a disease of rural communities where the majority of residents are of poor socioeconomic status, with an inadequate supply of clean water, unimproved sanitation, and poor hygiene [2] . However, evidence showed that urban settings are also affected by urogenital schistosomiasis [3–5].

Dar es Salaam is among cities with historical evidence of urinary schistosomiasis infection. In the early 1980s, the prevalence of urinary schistosomiasis in Dar es Salaam varied from 4 to 25% among school-aged children [2]. As the years went on, the prevalence of urogenital schistosomiasis was increasing in Dar es Salaam up to 47.6% in the 1990s [6]. The high burden of urogenital schistosomiasis in Dar es Salaam alerted the need for preventive chemotherapy (PC), and hence, was one of the first regions in Tanzania (mainland) to implement school-based PC using praziquantel under the national schistosomiasis and soil-transmitted helminths control program in 2006 [7].

A study conducted in 2011 to assess the status of schistosomiasis in school-aged children after two rounds (2006 and 2007) of PC intervention indicated a decrease in the prevalence of the disease [8,9]. Since then, little is known about the status of urogenital schistosomiasis from school-aged children in Dar es Salaam. However, studies were conducted in preschool-aged children and infants in 2015 and 2016, which reported the prevalence ranging from 1.2% to 1.9%, indicating the ongoing transmission of urogenital schistosomiasis in Dar es Salaam [10,11]. Therefore, this study was conducted to determine the current status of urogenital schistosomiasis, water, sanitation, and hygiene (WSH) risk factors, and uptake of praziquantel among primary school children in an urban endemic area of Kinondoni municipality in Dar es Salaam, Tanzania. The information collected will be useful for modifying the existing schistosomiasis control program to ensure sustainable control of the disease as we aim to attain the 2030 sustainable development goal three of health and wellbeing for all.

Methods

Description of the study area

This study was conducted in Kinondoni municipality, one of the five municipalities of the Dar es Salaam region. According to the census of 2012, the municipality has a total population of 1,775,049 (914,247 females and 860,802 males) with more than 446,504 households [12]. The municipality is boarded to the east by the Indian Ocean, north and west by the Coast Region. The area of Kinondoni has favorable climatic and ecological conditions that influence the survival of the *Bulinus* snail intermediate host of *S.haematobium* parasite. Kinondoni municipality was selected because it's one of the few endemic urban areas for urogenital schistosomiasis in Tanzania, with the ongoing praziquantel treatment program for more than ten years [10].

Study design

A school-based cross-sectional study involving a quantitative method of data collection was conducted between June and August 2020 to investigate the prevalence of urogenital schistosomiasis and WSH risk factors for transmission among primary school children in an urban endemic area of Kinondoni municipality in Dar es Salaam, Tanzania.

Study population, inclusion, and exclusion criteria

The study population was primary school children. All primary school children residents of Kinondoni municipality, aged 7 to 15 from classes four to six whose parents/guardian signed written informed consent form were eligible to participate. The students who were sick apart from urogenital schistosomiasis and whose parents/ guardians did not sign the written informed consent were excluded from participating in this study.

Sample size and sampling procedure

The sample size for this study was calculated from a formula for estimating sample size in a single cross-sectional survey [13], $n = \underline{z^2\ p\ (1-p)}\ /d^2$. n = sample size, z = level of confidence according to the standard normal distribution (for a level of confidence of 95%, z = 1.96), p = proportion of *S. haematobium* (p =19.3%) found in previous study [10], d = tolerated margin of error. Thus, $n= \underline{(1.96)^2\ (19.3\%)\ (100-19.3\%)}/(5)^2 = 239$. Assuming 10% non-response rate, adjusted sample was 263 school children.

The calculated sample size was 263 primary school children. Kigogo ward was purposively selected because of the history of urogenital schistosomiasis endemicity for three and a half decades [10]. Simple random selection was employed to determine the representative school for sample collection, whereby Kigogo primary school was determined.

Students from classes four to six were sampled according to the total number of students in each class, meaning the class with a higher number of students contributed to a higher sample size. A total of 100,120, and 30 students were sampled from classes 4, 5, and 6, respectively.

Urine collection and analysis

All of the sampled students were provided with labeled wide mouth dry plastic containers for collecting the urine samples and were instructed on how to collect terminal urine. The collected urine samples were transferred to the Parasitology and Medical Entomology Laboratory of Muhimbili University of Health and Allied Sciences on the same day for the urine analysis.

Microhaematuria analysis was done using a chemical reagent strip (Cybow 10 Urinalysis Test Strip). For each sample, the reagent strip was dipped into the mixed urine for three minutes then removed and read. The change of strip colour was compared to the colour chart on the strips' container to estimate the amount of blood in the urine. The results of microhaematuria were recorded as negative or positive.

Microscopic examination was done for each urine sample for detection of S.*haematobium* ova. The nucleopore membrane filtration technique was performed whereby 10mls of each urine sample was drawn using a 10ml plastic syringe and passed through a polycarbonate filter with a pore size of 12um to recover the eggs. All urine filters were carefully removed from filter holders and placed on the microscope slides, then stained with Lugol's iodine, and examined under the microscope with the magnification X10 and X40. The *S.haematobium* eggs were counted and reported as the number of eggs per 10 ml of urine. The intensity of *S.haematobium* infection was differentiated according to world health organization (WHO) categories of 1-49 eggs/10 ml as light infection and >50 eggs/10 ml as heavy infection [13].

Questionnaire survey

A structured questionnaire was prepared and used to collect information from primary school children. The questionnaire had 3 sections; the first section collected information on social-demographic characteristics of school children, the second section collected information on the uptake of praziquantel for prevention of urogenital schistosomiasis, and the third section collected information on WSH risk factors associated with the ongoing transmission of urogenital schistosomiasis among school children. Interviews were carried out after the collection of urine samples.

Data analysis

Data were checked for completeness, coded, entered, and cleaned using Statistical Package for the Social Sciences (SPSS) version 22. Descriptive statistics were computed to describe the prevalence of microhaematuria, prevalence, and intensity of *S.haematobium* ova according to social-demographic characteristics. The chi-square test (x^2) or Fisher's exact test and their related p-values at a significance level of *0.05* were used to measure the association between the dependent variable (prevalence of urogenital schistosomiasis), and independent variables including social-demographic characteristics (age, sex, and class), uptake of praziquantel and WSH factors.

Ethical considerations

The ethical clearance was requested and obtained from the Muhimbili University of Health and Allied Sciences Institutional Review Board (Ref.No PME 2017/04/10820-6th May 2020) before the study's commencement. Permission to conduct the study in Kinondoni municipality was sought from the regional to district and school authorities. The written consent forms describing the study's objectives, benefits and harms of participating in this study, and withdrawing rights from participation were distributed to eligible children to be given to their parents to read and sign if they consent their child to participate in this study. The children who were found positive for microhaematuria and *S.haematobium* were referred to a nearby dispensary for a further check-up, and treatment.

Results

Social demographic characteristics of the primary school children

A total of 263 primary school children from classes 4 to 6 were recruited in this study. However, only 250 provided urine samples and participated in the interview. Therefore, the rate of response was 95.1%. Of the 250 children who participated, more than half (53%) were males, the majority (74%) were aged between 11 to 14 years, and nearly half (48%) belonged to class five **(Table 1)**.

Prevalence of microhaematuria among primary school children

The overall prevalence of microhaematuria was 5.2%, being higher on females (3.2%), children aged between 11 to 14 years, and class five children (2.8%). There was a statistically significant

association between the prevalence of microhaematuria and age groups of the children (*p<0.00*) **(Table 2)**.

Prevalence of urogenital schistosomiasis among primary school children

The overall prevalence of urogenital schistosomiasis among primary school children was 1.2%. Males (0.8%) of class five and aged between 11 to 14 years were more affected compared to females. There was no statistically significant association between the prevalence of urogenital schistosomiasis and sex, age groups, or class of the student as presented in **table (3)**.

Intensity of urogenital schistosomiasis among primary school children

All infected primary children had light infection intensities as described by WHO on the categories for classification of *S.haematobium* infection intensities. The intensity of urogenital schistosomiasis among primary school children ranged from 6 to 8 eggs/10mls of urine with the overall arithmetic mean of 6.95 eggs/10 mL of urine. There was no statistically significant association between geometric mean egg intensity with sex, age, and a class of the students.

Water, sanitation, and hygiene risk factors associated with the transmission of urogenital schistosomiasis among primary school children

Out of 114 children living nearby water bodies, 61.4% were living near the Msimbazi river. More than half of the children were using piped water (62.4%) and flush toilets (58.8%). Of 137 children who had the habit of swimming in the Msimbazi river, 7.3% had the frequency of swimming daily. Only 70 children reported the habit of playing nearby water bodies, with 40% playing barefooted. The majority of the students (96.8%) reported engaging in activities in water sources. Of all the risk factors assessed for association, only type of latrines used at home (*p=0.044*) and frequency of swimming (*p=0.030*) were associated with transmission of urogenital schistosomiasis **(Table 4)**.

The uptake of praziquantel among primary school children in the last round of mass drug administration (MDA)

The majority of the children (86.4%) reported ever swallowed praziquantel during mass drug administration. However, only 77.2% were able to participate in the last round of MDA. For children who did not participate in the last round of MDA; the leading reasons were; fear of side effects (57.9%) and being sick (22.8%). Also, most of the children (84.4%) who participated in MDA reported experiencing the side effects of praziquantel, nausea (65%) being the leading side effect. There was a statistically significant association between prevalence of urogenital schistosomiasis with the children who have never swallowed praziquantel (*p<0.00*), experienced side effects (*p<0.00*), type of side effects experienced (*p=0.037*), and reasons for not taking praziquantel in the last round of MDA (*p=0.007*) **(Table 5)**.

Table 1. Social-demographic characteristics primary school children (n=250).

Variable	n (%)	95%CI
Sex		
Females	117(46.8)	40-54
Males	133(53.2)	46-60
Age group		
7-10 years	49(19.6)	14.5-25.0
11-14 years	185(74)	68.1-79.5
15-18 years	16(6.4)	3.6-9.5
Class		
Class four	100(40)	33.6-45.6
Class five	120(48)	42-53.5
Class six	30(12)	7.6-16

Table 2. Prevalence of microhaematuria among primary school children (n=250).

Social-demographic characteristics	Total	Microhaematuria present	Fisher's exact	*P-value*
Total	**250**	**13 (5.2)**		
Sex				
Females	117	8(3.2)	1.332	*0.539*
Males	133	5(2)		
Age group				
7-10 years	49	2(0.8)		
11-14 years	185	8(3.2)	12.054	*0.00*
15-18 years	16	3(1.2)		
Class				
Class four	100	3(1.2)		
Class five	120	7(2.8)	6.313	*0.049*
Class six	30	3(1.2)		

Table 3. Prevalence of urogenital schistosomiasis among primary school (n=250).

Social-demographic characteristics	Total	Microscopic observation of *S.haematobium*	Fisher's exact	*p-value*
Total	**250**	**3(1.2)**		
Sex				
Females	117	1(0.4)	0.221	*0.638*
Males	133	2(0.8)		
Age group				
7-10 years	49	1(0.4)		
11-14 years	185	2(0.8)	1.084	*0.775*
15-18 years	16	0(0.0)		
Class				
Class four	100	1(0.4)	0.486	*0.734*
Class five	120	2(0.8)		
Class six	30	0(0.0)		

Table 4. Water, sanitation, and hygiene risk factors associated with the transmission of urogenital schistosomiasis among primary school children (n=250).

Variable	n(%)	*S.haematobium* positive	Fisher's exact	*p-value*
Live nearby water body				
Yes	114(45.6)	2(0.8)	0.543	*0.461*
No	136(54.4)	1(0.4)		
Type of water body near home				
Pond				
River	44(38.6)	0(0.0)	1.887	*0.301*
	70(61.4)	2(0.8)		
Source of the water at home				
Piped water				
Dug well	156(62.4)	0(0.0)		
River	38(15.2)	1(0.4)	4.151	*0.292*
Water kiosk	33(13.2)	1(0.4)		
	23(9.2)	1(0.4)		
Type of latrines at home				
None				
Pit latrine	11(4.4)	0(0.0)		
Flush toilet	60(24)	1(0.4)	5.491	*0.044*
San plat latrine	147(58.8)	2(0.8)		
	32(12.8)	0(0.0)		
Habit of swimming				
Yes				
No	137(54.8)	2(0.8)	0.173	*0.678*
	113(45.2)	1(0.4)		
Frequency of swimming				
Daily				
Weekly	10(7.3)	1(0.4)		
>Weekly	30(21.9)	2(0.8)	6.222	*0.030*
	97(70.8)	0(0.0)		
Play nearby water bodies				
Yes				
No	70(28)	2(0.8)		
	180(72)	1(0.4)	2.252	*0.133*
Type of shoes worn While playing near water bodies				
Closed shoes				
Open shoes	25(35.7)	0(0.0)	5.406	*0.144*
No shoes(barefooted)	17(24.3)	1(0.4)		
	28(40)	2(0.8)		
Doing activities in water sources				
Yes				
No	242(96.8)	3(1.2)	0.1	*0.751*
	8(3.2)	0(0.0)		
Type of activity done in water sources				
Fetching water for domestic and irrigation	57(23.5)	1(0.4)	4.66	*0.458*
Washing dishes	36(14.8)	0(0.0)		
Washing clothes	87(36)	0(0.0)		
Cross point	42(17.4)	1(0.4)		
Bathing	20(8.3)	1(0.4)		

Table 5. Self-reported uptake of praziquantel in the last round of MDA (n=250).

Variable	n(%)	*S.haematobium* Positive	Fisher's exact	p-value
Never swallowed praziquantel during MDA				
Yes	34 (13.6)	3(1.2)	19.3	0.000
No	216 (86.4)	0(0.0)		
Swallowed praziquantel in the last round of MDA				
Yes	193(77.2)	0(0.0)	3.32	0.048
No	57(22.8)	3(1.2)		
Reasons for not taking praziquantel in the last round				
Sick	13(22.8)	0(0.0)		
Fear of side effects	33(57.9)	0(0.0)	9.6	0.007
Parent did not allow	6(10.5)	2(0.8)		
Absent from the school	5(8.8)	1(0.4)		
Experienced praziquantel side effects				
Yes	211(84.4)	0(0.0)	16.428	0.000
No	39(15.6)	3(1.2)		
Praziquantel side effects experienced				
Nausea	137(65)	0(0.0)		
Vomiting	26(12.3)	0(0.0)		
Dizziness	12(5.7)	0(0.0)		
Sweating	9(4.2)	0(0.0)	13.495	0.037
Malaise	8(3.8)	0(0.0)		
Headache	8(3.8)	0(0.0)		
Upset stomach	6(2.8)	0(0.0)		
Itching	5(2.4)	0(0.0)		

Discussion

Our findings indicate the low prevalence (1.2%) of urogenital schistosomiasis among school children, and all infections were of light intensities. There is a decrease in the prevalence of urogenital schistosomiasis among school-aged children in Kinondoni municipality from 41.6% in 1992 to 1.2% from this study [6]. The reduction or decline in prevalence could be due to a decade of praziquantel administration [7,14], high coverage of piped water supply, and latrine facilities. Despite the observed low prevalence, it's evident that transmission is still going on, and the primary school children could serve as a source of transmission to other community members.

Haematuria is a recognized clinical feature and morbidity indicator of *S.haematobium* infection [15]. The prevalence of microhaematuria was higher (5.2%) than the overall prevalence of urogenital schistosomiasis (1.2%). The observed low prevalence of *S.haematobium* infection compared to the prevalence of microhaematuria is possible in low endemic settings where the shedding of eggs is low and thus challenging to detect eggs by the single filtration of a urine sample. Also, the high prevalence of microhaematuria could be due to

menstruation blood residual, considering that the higher prevalence (3.2%) was observed among females aged 11 to 14 years. Studies have reported the menstruation blood and persistence of bladder lesion for an extended period than the actual time for shedding *S.haematobium* eggs as the reason for the high prevalence of microhaematuria [16–18].

Inadequate water supply, poor sanitation and hygiene are among the risk factors for transmission of urogenital schistosomiasis in endemic settings [19–21]. Our study's findings revealed that all of the infected students were not using the piped water, and most of them were living near the Msimbazi river. The frequent exposure to the water of the Msimbazi river when swimming, fetching water, crossing, playing barefooted, and utilization of water from the river for bathing were the risk factors identified from the students for the ongoing transmission of urogenital schistosomiasis in the study area despite the ongoing mass deworming. The findings are comparable with the previous studies on Tanzania, Nigeria, Senegal [6,19,22,23].

The types of latrine used at home were statistically significantly associated with the prevalence of urogenital schistosomiasis. In this study, most of the affected children came from households with flush toilets. Owning and using the flush toilets at home does not prevent the children from acquiring urogenital schistosomiasis, especially if there are still frequent contacts to the river. There is a possibility that the children acquired the infection when swimming, bathing, or playing in the Msimbazi river. This study's findings agree with the research conducted in South Africa, which reported that all of the urogenital schistosomiasis-infected children came from the household owning different types of toilets [24].

The frequency of swimming was statistically significantly associated with the prevalence of urogenital schistosomiasis. All the infected students reported daily or weekly swimming in the Msimbazi river. Children tend to urinate in the water sources while swimming; hence the infected child can contaminate the water sources [25]. It has been reported that the frequency of water contact activities such as swimming increase the risk of transmitting or acquiring the infection in endemic settings [26–28].

Acceptability and uptake of praziquantel among primary school children are crucial for the control of urogenital schistosomiasis and the prevention of long-term morbidity [29]. The study findings revealed a statistically significant association between the uptake of the praziquantel and the prevalence of urogenital schistosomiasis. All of the infected students self-reported never taking praziquantel drugs due to parents' refusal or absence at the school during praziquantel administration. The observed prevalence in this group is because they have never taken the praziquantel in their lifetime. Studies have reported fear of side effects of the praziquantel, absence from the school during praziquantel distribution, parents' refusal to participate without specific reasons, and inadequate communication with the parents on the rationale of the praziquantel uptake as among the reasons that affect the acceptability and uptake of praziquantel treatment [30-32]. The self-reported uptake of praziquantel was above the WHO target [33]. This could be due to the ongoing neglected tropical diseases control program campaigns before the distribution of praziquantel. The majority of the students (84.4%) reported side effects due to the uptake of praziquantel. The side effects attributed by the uptake of praziquantel tends to affect the acceptability and hence coverage of the praziquantel in the endemic settings [30].

Study limitations

The study had the following limitations; the urine samples were collected only once, which might have underestimated the prevalence of urogenital schistosomiasis among primary school children in the study area. Another limitation was recall bias; some of the questions required the primary school children to recall the previous year's information, such as the uptake of praziquantel treatments and side effects experienced; this might have affected the information's accuracy provided. Also, some information regarding WSH practices reported by children may be subjective and unreliable compared to observing them using a checklist.

Conclusions

The study revealed the low prevalence of urogenital schistosomiasis among primary school children in the Kinondoni municipality. Despite the low prevalence, it's an indication of the ongoing transmission of the disease. The risk factors that trigger the ongoing transmission of urogenital schistosomiasis in the study area include; frequency of swimming in Msimbazi river, type of latrine used at home, never swallowed praziquantel, experienced side effects, type of side effects experienced, and

reasons for not taking praziquantel in the last round of MDA.

The small group of students who never swallowed the praziquantel could compromise the ongoing efforts to control schistosomiasis by praziquantel treatment and serve as the infection reservoir. Therefore, there is a need to emphasize health education to both the parents and children, focusing on the importance of praziquantel treatment to ensure no children are left behind during MDA.

Conflict of interest statement

We declare that we have no conflict of interest.

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Authors' contributions

YY and VM conceptualized the study, YY did data collection and laboratory work, VM analyzed the data, and VM and AZ drafted the manuscript. All authors read and approved the manuscript.

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