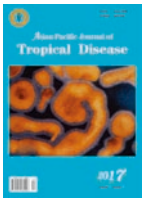
Asian Pacific Journal of Tropical Disease

journal homepage: http://www.apjtcm.com



Parasitological research https://doi.org/10.12980/apjtd.7.2017D6-359 ©2017 by the Asian Pacific Journal of Tropical Disease. All rights reserved.

Urinary schistosomiasis among preschool-age children in an endemic area of Kinondoni municipality, Dar es Salaam, Tanzania 2016

Samwel Bushukatale Ng`weng`weta, Donath Samuel Tarimo*

Department of Parasitology & Medical Entomology, School of Public Health & Social Sciences, Muhimbili University of Health & Allied Sciences, Dar es Salaam, Tanzania

ARTICLE INFO

Article history:
Received 8 Oct 2016
Received in revised form 26 Oct, 2nd revised form 31 Oct 2016
Accepted 16 Nov 2016
Available online 5 Dec 2016

Keywords:
Praziquantel
Preventive chemotherapy
Urinary schistosomiasis
Preschool-age
Tanzania

ABSTRACT

Objective: To examine the magnitude of *Schistosoma haematobium* (*S. haematobium*) infection and the factors associated with exposure of preschool children in Kigogo Ward, Kinondoni District, Dar es Salaam.

Methods: A quantitative cross-sectional survey of Class I pupils (preschool-age in 2015) was carried out from May to June 2016 to examine the prevalence and intensity of *S. haematobium* infection and associated factors. Urine samples were examined for haematuria, *S. haematobium* eggs and intensity. Parents or guardians were interviewed on their awareness and level of knowledge on urinary schistosomiasis disease (symptoms, mode of transmission, treatment and prevention), as well as their perceived risk of infection to young children. Potential sites of transmission were identified and searched for *Bulinus* spp., snails and the activities that exposed young children to infection were recorded.

Results: A total of 424 pupils and 408 female parents or guardians were recruited. Haematuria was detected in 51 (12.0%) pupils, *S. haematobium* eggs were observed in 8 (1.9%) pupils and all were light infection. *Bulinus* spp., snails were identified mostly at cross-points of rivers. The large majority (91.7%) of parents or guardians were aware of urinary schistosomiasis disease, but three quarter (76%) did not consider it as a health problem. More than two thirds (71.3%) reported that anybody could get urinary schistosomiasis; two thirds (65.9%) reported that infection was likely to be acquired at cross-points of rivers. The large majority (> 90%) had the notion that young children could be exposed; and all the activities that might lead a child to come into contact with potentially infested waters were judged to be risk factors. The larger majority (83.6%) had a high level of knowledge on urinary schistosomiasis (transmission, symptoms, availability of modern treatment and the preventive measures), reflecting the ongoing advocacy campaigns.

Conclusions: Young children left out in praziquantel preventive chemotherapy harbor *S. haematobium* infection and are likely to be the source of environmental contamination frustrating the national efforts for control. Presence of *Bulinus* spp. snails shows the potential for the continuity of *S. haematobium* transmission.

1. Introduction

Infection with *Schistosoma haematobium* (*S. haematobium*), a parasitic dioecious trematode, transmitted by snails of the *Bulinus* species, causes urinary schistosomiasis whose common early signs include microscopic and visible haematuria that precede the development of urological abnormalities such as urinary bladder calcification, deformed ureters and kidneys in the form of hydronephrosis[1,2]. The control of schistosomiasis in sub-Saharan Africa, including Tanzania, have focused primarily on school-aged children, excluding preschool-age children and adults[3,4]. Despite the high coverage of school-aged children with praziquantel preventive chemotherapy with significant reductions in morbidity among school age children, infants, preschool-age children and other community groups living in close proximity to potentially infected water bodies are likely to be infected and be the source of shedding *S. haematobium* eggs in the environment and continuity of transmission[5,6]. Hence, there is need to consider the groups left out in the praziquantel preventive chemotherapy campaigns[7-10]. The frequency of schistosome infections among infants and young

*Corresponding author: Donath Samuel Tarimo, United Nations Road, P.O.Box 65015, Dar es Salaam, United Republic of Tanzania.
Tels: +255 754 820 439 (BS Ng`weng`weta); +255 754 578 528 (TD Samuel)
E-mails: sbushukatale@gmail.com (BS Ng`weng`weta); dontarimo@gmail.com (TD Samuel)

The study protocol was performed according to the Helsinki declaration and approved by the Institutional Review Board of the Muhimbili University of Health and Allied Sciences. Informed verbal and written consent for participation in the survey was obtained from each participant.

The journal implements double-blind peer review practiced by specially invited international editorial board members.

children is increasingly being recognized, a situation previously overlooked partly because of emphasizing on school children, low output of parasite egg and the low sensitivity of the currently used diagnostic methods[8].

Available data show that preschool children get schistosomiasis through early exposure to infected water bodies and contributing largely to the continuity of transmission[7,11]. Contrary to previous assumptions, there is an evidence that *Schistosoma* infection starts from early childhood in many endemic communities and the factors associated with exposure of preschool children to infection are yet to be determined[11,12]. It has been shown that development of morbidity in early childhood may contribute to long-term clinical impact and severity of schistosomiasis before they receive treatment at school age[13]. There is therefore a need to establish the magnitude of *S. haematobium* infection among young children excluded in praziquantel preventive chemotherapy with the view to inform policy makers on the need for including preschool children in praziquantel preventive chemotherapy campaigns which should go hand in hand with the provision of health education to mothers or caregivers regarding exposure to infection in early childhood[12]. It is clear that mothers or caregivers contribute substantially to expose their young children to *Schistosoma* infection, thus health education messages should target them focusing on their roles in avoiding taking their young children to potentially infect water bodies[8,13].

This study examined the magnitude of *S. haematobium* infection among preschool-aged children, potential sites of *S. haematobium* transmission and presence of snails of *Bulinus* spp. the intermediate host of *S. haematobium*, awareness and level of knowledge of parents or guardians on urinary schistosomiasis disease in terms of symptoms, mode of transmission, availability of modern treatment and preventive measures. The study also sought to establish perceived risk of *S. haematobium infection* of mothers or caregivers in different age groups and water contact sites and practices might lead to exposure to *S. haematobium* infection in young children[14]. The goal was to generate information that would guide policy decision to consider inclusion of preschool children in praziquantel preventive chemotherapy and targeted health education messages to mothers or caregivers regarding control of schistosomiasis among young children.

2. Materials and methods

2.1. Study area

The study was conducted in Kinondoni, one of the administrative municipalities of Dar es Salaam City. Dar es Salaam region was selected because it is endemic for schistosomiasis and was targeted for preventive chemotherapy among children of school age[3]. The Kinondoni municipality is located on the coastal plains and has favourable ecological conditions that facilitate thriving of snails of the *Bulinus* spp., the intermediate hosts of *S. haematobium*; thus it is known to be endemic for urinary schistosomiasis over the last three decades[3,15]. Prior to launching of the praziquantel preventive chemotherapy to school children by the National Schistosomiasis Control Programme, the prevalence of *S. haematobium* infection in Kinondoni was 16.7% according to the blood in urine questionnaire of World Health Organization, which is equivalent to an average microscopic prevalence of 30.0%[3]. Five rounds of praziquantel preventive chemotherapy had been implemented and the fifth round had been implemented in November 2015 and this study was carried out 6 months later (May to June 2016).

2.2. Study design

A quantitative cross-sectional study was carried out in May 2016 to examine the prevalence and intensity of *S. haematobium* infection among Class I pupils who were preschool-age in the previous year, 2015 and the community factors (awareness, knowledge and practices) associated with exposure to *S. haematobium* infection among young children.

2.3. Study population and sample size

Two kind of study populations were recruited: Class I pupils, who were preschool-age in the previous year (2015) and therefore did not receive praziquantel preventive chemotherapy; and female parents or guardians.

2.4. Class I pupils

2.4.1. Inclusion criteria

Class I pupils who were present at the school during the study and whose parents or guardians on their behalf gave consent for their participation in the study were recruited to provide urine samples for the assessment of prevalence and intensity of *S. haematobium* infection. Exclusion criteria: Class I pupils whose parents or guardians did not give consent for their participation in the study.

2.5. Community members

Mothers or caregivers were recruited for the assessment of factors (awareness, knowledge and practices) associated with exposure to *S. haematobium* infection among preschool children.

2.6. Sample size estimation

The sample size for estimating the prevalence of *S. haematobium* among Class I pupils was calculated using a prevalence of 50.0% (since there was no previous figure) that was the largest sample size[16]; thus using the formula for estimating sample size in a single cross-sectional survey: $N = (z/d)^2 \times p\ (1–p)$

where, N is the desired sample size; z is SD (1.96) which corresponds to 95% confidence interval; p is estimated prevalence of *S. haematobium* in preschool children in the study area (50.0%); d is marginal error (5%).

$N = (1.96/0.05)^2 \times 0.5\ (1 – 0.5) = 385$

Adding 10% for non-responses, drop outs and missing data (0.1 × 385), the sample size was 424 in Class I pupils.

The sample size for female parents or guardians was taken to correspond to the number of sampled pupils since each pupil the female parent or guardian was visited at the household for a questionnaire interview.

2.7. Sampling procedures

Kigogo, Mkwawa and Lutihinda primary schools were purposefully selected as they had over the last three decades been shown to be endemic for *S. haematobium* infection[13]. Request for participation in the study was sent to parents by Class I pupils; pupils whose parents or guardians consented were recruited in the study. For each recruited pupil, his/her mother or caregiver was

visited at the household for questionnaire interview.

2.8. Data collection instruments

For urinalysis, the following instruments were put in place: wide-mouth plastic containers with a screw cup with capacity of 50 mL, syringes with capacity of 10 mL, centrifuge machine and centrifuge tubes, a complete set of urine filters and laboratory forms. For the assessment of community factors associated to exposure of preschool age children to *S. haematobium* infection, a pre-coded questionnaire with closed end questions was administered to the female parent or guardian of each recruited Class I pupil. In addition, a design check list form was used to record water contact sites and exposed risks of *S. haematobium* infection.

2.9. Collection of urine samples, processing and macroscopic examination

Urine samples were collected between 10 and 14 h, the time for peak eggs production. Sampled pupils were instructed to do brief jogging (5 min) and each was provided with a wide-mouth clean dry plastic container bearing name and serial number; in liaison with the class teacher, they were instructed to go to the bathroom to produce a urine sample. Under the guidance of the class teacher, the pupils were instructed to ensure that each submited a urine sample and they were counseled to produce a terminal urine sample, not to exchange containers, and not to share urine samples. The urine samples were transferred to Parasitology Laboratory of Muhimbili University of Health and Allied Sciences the same day where macroscopic analysis for visible haematuria was done; for the detection of microhaematuria, a chemical reagent strip (haemastix, Tarrytown, NY 10591-5097 USA) was used. The reagent strip was dipped into the urine, being mixed well for 3 s then removed immediately. The colour change in the strip was compared with the colour chart on the container of the strips to estimate the amount of blood in the urine, and the results were recorded as negative, +, ++ or +++ as per manufacturer recommendations. Each sample was then fixed with formalin before microscopic examination.

2.10. Urine microscopic examination for patency and count of S. haematobium eggs

Prevalence of *S. haematobium* eggs was assessed by urine centrifugation whereby 10 mL urine was centrifuged at 3 000 r/min for 5 min; a wet mount preparation stained with Lugol's iodine was made from the obtained deposit and examined microscopically under ×10 and ×40 magnification and results were recorded as presence or absence of *S. haematobium* eggs.

Intensity of infection was established by the urine filtration method, whereby each urine sample of 10 mL was strained through a polycarbonate membrane filter with 13 mm diameter and 12 microns pore size, which was stained with Lugol's iodine and examined microscopically under ×10 and ×40 magnification. Egg counting was done under ×40 magnification and the results were recorded as number of eggs per 10 mL of urine.

2.11. Interviews of mothers or caregivers

To assess community factors associated with exposure of preschool children to *S. haematobium* infection, each mother or caregiver was interviewed regarding level of awareness and knowledge on symptoms of urinary schistosomiasis, mode of transmission, treatment and prevention, as well as their perceptions on the potential risk of *S. haematobium* exposure to their young children. They were also interviewed as to whether any child in the family had a history of passing blood in urine in the past 6 months and the source of water for routine domestic use.

2.12. Establishment of water contact sites, exposure risk to preschool children and snails searching

Water bodies surrounding the schools were identified and various activities were conducted to make female parents or guardian to visit these water bodies. The water bodies were listed. Using the observation check list, the activities making parents or guardians to contact with the water bodies in the company of their preschool age children were listed. This was followed by searching for *Bulinus* spp. snails and the intermediate hosts of *S. haematobium* in the respective water contact sites. A scoop was used to collect snails, which were preliminarily assessed morphologically as to whether they were of the *Bulinus* spp.. Final identification of the snails was conducted at the Parasitology Laboratory of Muhimbili University of Health and Allied Sciences. Using standard keys, the snails were identified as *Bulinus* spp. based on the morphological characteristics of their shells[17,18].

2.13. Data management and analysis

All questionnaires were coded based on specified serial numbers. On each day, the principal investigator reviewed all questionnaires to ensure consistency and proper filling of the information in order to ensure quality data. Urine samples were examined by two experienced microscopists and their results were compared each time. Data were cleaned and double entered in the computer using SPSS version 20 statistical package. Descriptive analysis was done to calculate prevalence and intensity of *S. haematobium* eggs among Class I pupils. Parents' or guardians' awareness, knowledge level and perceptions of urinary schistosomiasis disease were assessed against socio-demographic characteristics. Knowledge was assessed on a scale of 10 points score with categories: 1–4 showed low knowledge, 5–7 showed medium knowledge and 8–10 showed high knowledge. The categories followed correct mentioning of the modes of transmission (contact with cercariae infested waters), symptoms of the disease (blood in urine, painful urination, supra-pubic pain and lower or flank abdominal pains), availability of treatment (can be treated by modern medicine) and preventive measures (avoid urination in water sources, avoid contact with unsafe water sources, use of safe source of water such as taps and wells for domestic use and participation in praziquantel preventive chemotherapy advocacy campaigns to constitute 10 points. The *Chi*-square test was used to examine the associations between variables of interest, at the significance level of 0.05.

2.14. Ethical considerations

The study protocol was performed according to the Helsinki Declaration and approved by the Institutional Review Board of the Muhimbili University of Health and Allied Sciences. Informed verbal and written consent for participation in the survey was obtained from each participant. Permission to carry out the study was sought from the administrative authorities of Kinondoni Municipality and Kigogo Ward. At school, permission to carry out the study was sought from the head teacher in liaison with the class teacher. Results of urinalysis were communicated to parents or guardians and pupils found infected were referred to the nearest health facility for treatment.

3. Results

A total of 424 Class I pupils from the three primary schools of Kigogo, Mkwawa and Rutihinda were recruited in the study and the same sample size of female parents or guardians were expected to be recruited. The response rate for Class I pupils was 100%. For the female parents or guardians, 16 did not consent to participate in the interviews, with a response rate of 96.2% and the rate of non-response was thus < 10%.

3.1. Magnitude of S.haematobium infection among Class I pupils

Table 1 shows the characteristics of the studied Class I pupils. Of the 424 pupils, 218 (51.4%) were females, with a mean age of 6.4 years and the large majority (92%) were 6–7 years old. A total of 51 (12.0%) pupils had haematuria, of which 27 (6.3%) were females while 24 (5.9%) were males. The prevalence of haematuria was similar in all schools, being mostly common in pupils 6–7 years old. *S. haematobium* eggs were observed in 8 (1.9%) pupils with a mean intensity of infection of 37 eggs/10 mL of urine and all were light infections.

Table 1
Characteristics of the studied Class I pupils (n = 424) [n (%)].

Attribute		Haematuria	*S. haematobium* eggs
Sex	Females	27 (6.3)	6 (1.4)
	Males	24 (5.7)	2 (0.5)
School	Kigogo	16 (3.8)	3 (0.7)
	Mkwawa	19 (4.5)	3 (0.7)
	Rutihinda	16 (3.8)	2 (0.5)
Age	5 years	5 (1.2)	2 (0.5)
	6 years	23 (5.4)	2 (0.5)
	7 years	23 (5.4)	4 (0.9)
	8 years	0 (0.0)	0 (0.0)

3.2. Snail survey to establish potential breeding and transmission sites

A total of 12 fresh water sites in the Msimabazi and Kigogo rivers were searched for the presence of *Bulinus* spp. snails. From Kigogo river, two different sites were found to be infested with bulinid snails and 50 of which were collected and 30 were identified as being *Bulinus* spp.

Water contact practices with the potential of exposing young children to *S. haematobium* infection were assessed by observation. Mothers or caregivers in the company of young children were often seen getting into the Kigogo river sites from where the *Bulinus* spp. snails were collected (Figure 1).

Figure 1. Photo showing preschool children accompanying parents or guardians to ferry water for irrigating vegetables in gardens at two different sites along Kigogo river.

3.3. Survey of risk factors for exposure to S. haematobium infection among young children

A total of 408 mothers or caregivers participated in the study, with a response rate of 96.2%. Table 2 shows the sociodemographic characteristics of the study participants. About 72.8% participants were married and about one third (35.3%) had reached secondary level education.

Table 2
Sociodemographic characteristics of the female parents or guardians (n = 408).

Attribute		No.	Percentage
Age group (years)	18–27	115	28.2
	28–37	166	40.7
	38–47	95	23.3
	Above 48	32	7.8
Marital status	Not married	73	17.9
	Married	297	72.8
	Separated	16	3.9
	Divorced	4	1.0
	Widowed	11	2.7
	Cohabiting	7	1.7
Level of education	Primary	251	61.5
	Secondary	144	35.3
	Post-secondary	13	3.2
Occupation	Peasant	14	3.4
	Petty business	213	52.2
	Employed	56	13.7
	Housewife	125	30.6

Awareness was assessed in terms of having ever heard the disease, whether it is a health problem, if there was a child who had ever suffered from the disease and whether there was a child with symptoms of blood in urine in the last 6 months (Table 3). The large majority (91.7%) had heard about urinary schistosomiasis disease and a high percentage (76.0%) did not consider it as a health problem, probably because only a small percentage reported any child to have suffered from the disease (14.5%) or had a child with blood in urine (12.7%).

Table 3
Awareness on urinary schistosomiasis disease (n = 408).

Attribute		No.	Percentage
Ever heard the disease	Yes	374	91.7
	No	34	8.3
As a health problem	Yes	98	24.0
	No	310	76.0
Any child ever suffered the disease	Yes	59	14.5
	No	349	85.5
Any child with blood in urine 6 months ago	Yes	52	12.7
	No	356	87.3

Regarding perceptions on age groups likely to get urinary schistosomiasis and activities that could lead to exposure to infected water bodies, a high percentage (71.3%) held the perception that anybody could get urinary schistosomiasis, while two thirds (65.9%) reported that at cross-points of rivers, the activity was more likely to lead to exposure to infection with *S. haematobium* (Table 4). The large majority (> 90%) held the perception that young (preschool children) could be exposed to and get urinary schistosomiasis and all the activities that might lead a child into contact with potentially infected waters were judged to be risk factors (Table 5).

Table 4
Perceived age group likely to get urinary schistosomiasis and activities (n = 408).

Attribute		No.	Percentage
Age group likely to get the disease	Pre-school age	43	10.5
	School age	65	16.0
	Adults	6	1.5
	Any body	291	71.3
	Don't know	3	0.7
Water contact activities	Washing clothes	82	20.1
	Bathing	62	15.2
	Washing grains	70	17.2
	Crossing points	269	65.9
	Fetching domestic water	112	27.5

Table 5
Perceived risk of exposure and practices of parents or guardians leading to *S. haematobium* in preschool age children (n = 408).

Attribute	No.	Percentage
Opinion that young children could get urinary schistosomiasis	398	97.5
Child went with me to bath in water bodies and got into water	402	98.6
Child went with me to wash grains and got into water	401	98.3
Child went with me at cross-points and got into water	402	98.5
Child went with me to fetch water and got into the water	403	98.7
Child bathed with water ferried from stagnant water bodies	401	98.3

In assessing knowledge on urinary schistosomiasis disease, knowledge level was assessed on a scale of 10 points score with the following categories: 1–4 showed low knowledge; 5–7 showed medium knowledge and 8–10 showed high knowledge (Table 6). The categories followed correct mentioning of the modes of transmission (contact with cercariae infested waters), symptoms of the disease (blood in urine, painful urination, supra-pubic pain and lower or flank abdominal pains), availability of treatment (can be treated by modern medicine) and preventive measures (avoid urination in water sources, avoid contact with unsafe water sources, use of safe source of water such as taps and wells for domestic use and participation in praziquantel preventive chemotherapy advocacy campaigns to constitute 10 points). The larger majority (83.6%) had a high level of knowledge about urinary schistosomiasis as a disease from the viewpoints of transmission, symptoms, availability of modern treatment and the preventive measures; conceivably reflecting the ongoing praziquantel preventive chemotherapy advocacy campaigns by the Ministry of Health. Marital status was the only demographic characteristic found to be associated with knowledge level (Table 7), indicating that married couples were more likely to share health related knowledge.

Table 6
Knowledge of parents or guardians on urinary schistosomiasis disease (n = 408).

Knowledge categories	No.	Percentage
Low knowledge	7	1.7
Medium knowledge	60	14.7
High knowledge	341	83.6

Table 7
Relationship of sociodemographic characteristics with knowledge on urinary schistosomiasis disease (n = 408).

Characteristics		Low [n (%)]	Moderate [n (%)]	High [n (%)]	*Chi*-test (Fisher's exact test)	P value
Age group (years)	18–27	1 (0.9)	15 (13.0)	99 (86.1)	3.236	0.771
	28–37	5 (3.0)	27 (16.3)	134 (80.2)		
	38–47	1 (1.1)	12 (12.6)	82 (86.3)		
	Above 48	1 (3.1)	5 (15.6)	26 (81.2)		
Marital status	Not married	0 (0.0)	18 (24.7)	55 (75.3)	17.890	0.019
	Married	6 (2.0)	34 (11.4)	257 (86.5)		
	Separated	0 (0.0)	3 (18.8)	13 (81.2)		
	Divorced	1 (25.0)	0 (0.0)	3 (75.0)		
	Widowed	0 (0.0)	2 (18.2)	9 (81.8)		
	Cohabiting	0 (0.0)	3 (42.9)	4 (57.1)		
Level of education	Primary	8 (3.2)	30 (12.0)	213 (84.8)	7.388	0.095
	Secondary	0 (0.0)	26 (18.1)	118 (81.9)		
	Post-secondary	0 (0.0)	3 (23.1)	10 (76.9)		
Occupation	Peasant	1 (7.1)	0 (0.0)	13 (92.9)	8.823	0.142
	Petty business	2 (0.9)	36 (16.9)	175 (82.2)		
	Employed	0 (0.0)	11 (19.6)	45 (80.4)		
	Housewife	5 (4.0)	12 (9.6)	108 (86.4)		

4. Discussion

This study examined the magnitude of urinary schistosomiasis in Class I pupils excluding in praziquantel preventive chemotherapy campaigns in the previous year as they were preschool age. To our understanding, this is the first study in Tanzania mainland to attempt to examine the magnitude of *S. haematobium* infection in children excluding receiving praziquantel preventive chemotherapy campaigns. Although the prevalence of *S. haematobium* infection was low (1.9%) and all were light infections, the findings demonstrate that young children contribute to the burden of urinary schistosomiasis in the studied community as demonstrated in other sub-Saharan Africa countries[7,13,19-25]. Early childhood infection undoubtedly contributes to pathology among preschool children in endemic areas, thus the finding of 12.0% prevalence of blood in urine indicates a probable cryptic morbidity of damage in the urinary tract due to *S. haematobium* infection despite the observed low prevalence (1.9%) of patent eggs count, all with a light intensity which is common in preschool age children[26]. The observed low prevalence of *S. haematobium* infection may be explained by the low sensitivity of the egg counts method used that are the corner stone of measurement of morbidity of schistosomiasis, which may not be optimal in the presence of light intensity of infection[27]. Nevertheless, the finding demonstrates that *S. haematobium* transmission is ongoing and with continued contact with water bodies infested with *Bulinus* spp. snails and the infection will build up in as long as young children accompanied with parents or guardians to water bodies infested with *Bulinus* spp. snails like the Kigogo river for their day to day livelihood activities as shown in

this study. Contrary to the earlier thought that preschool age children are at a low risk of schistosomiasis because of infrequent contact with potentially infected water bodies, out socio-cultural practices, young children accompany with mothersor caregivers in livelihood activities that put them at a considerable risk of schistosomiasis[28].

Schistosomiasis in preschool children plays an important role of maintaining transmission of disease at local level because they are excluded in the national praziquantel preventive chemotherapy campaigns[11]. For preschool children, despite harboring light infection, their regular water contact in the company of their mothers or caregivers, leads to dissemination of *S. haematobium* eggs and thus contamination of the water contact sites. This age-group is likely to play an increasingly important role in contaminating the environment and maintain transmission despite the major achievements made by national programmes to cover up school age children by praziquantel preventive chemotherapy campaigns with a focus on reductions in morbidity and environmental transmission[4]. The regular water contact by preschool children in the company of their mothers or caregivers as shown in this study, is the potential for recurrent reinfection episodes that would lead to a progressive increase in individual worm load in infected children. Since infection acquired in early childhood is not treated, it will worsen the long-term clinical picture of the disease in the individual children as soon as they start schooling, hence there is need to revise policy including preschoolers in praziquantel preventive chemotherapy campaigns[8,29]. School children covered by praziquantel preventive chemotherapy are also likely to be at risk of reinfection if they continue to make contact with potentially infected water bodies that are frequented by mothers or caregivers in the company of their infected young children[10].

The high awareness on urinary schistosomiasis disease observed in this study is a result of the five rounds of school-based praziquantel preventive chemotherapy campaigns adopted by the Tanzanian government through the Ministry of Health to cover regions endemic for *S. haematobium*, including the Kinondoni District and the fifth round has been administered in November 2015, six months before the study commenced[3]. Although the large majority (91.7%) was aware of schistosomiasis disease, a high percentage (76.0%) did not consider it as a health problem, perhaps because only a small percentage (12.7%) was reported for a child who was passing blood in urine, the main symptom of urinary schistosomiasis. The notion that urinary schistosomiasis is not a health problem may negatively affect national control efforts[14]. The intensive praziquantel preventive chemotherapy campaign seems to induce positive perceptions that anybody can get urinary schistosomiasis disease and that cross-points are the common sites of making contact with cercariae infested water bodies[3,10]. It is for the same reasons that the large majority could express that young children can also get schistosomiasis through all practices that can expose them to cercariae infested waters like bathing with freshly drawn environmental water, either at the water's source or at home representing passive rather active exposure through the practices of their mothers or caregivers[30].

The public education campaigns of intensive praziquantel preventive chemotherapy have generated a very high level of knowledge as demonstrated by the larger majority (83.6%) to have a comprehensive knowledge about urinary schistosomiasis disease regarding mode of transmission, symptoms, availability of modern treatment and the preventive measures that includes participation in praziquantel preventive chemotherapy campaigns in schools so as to cover Class I pupils who did not participate in the previous year[3].

The demonstration of the presence of *Bulinus* spp. snails, the principal intermediate hosts from two different water bodies especially at cross-points associated with human water contacts, have the potential for *S. haematobium* transmission in the study area[31,32]. The Kigogo river showed a suitable environment for flourishing the snails: the water was flowing with a slow speed, muddy and contained floating aquatic weeds that are ideal ecology for the snail species. There were many human activities such as attending vegetables gardens and drawing water for irrigation from the river. Likewise, there were many cross-points to the other side indicating the possibility of human to come into contact with water in the river. In most cases, mothers or caregivers accompanied by their young children to draw water from the river for irrigating the gardens and socio-cultural practices can facilitate passive exposure of young children to *S. haematobium* infection[8]. Although the sampled *Bulinus* spp. snails did not shed cercariae, their mere presence is an indication for the potential of *S. haematobium* transmission. Thus, as we move from morbidity control to transmission control, there will be a need to revise policy so as to cover up the groups left out in the praziquantel preventive chemotherapy campaigns including preschoolers as they will be the source of shedding *S. haematobium* eggs in the environment and therefore continuity of transmission[33,34].

About 3.8% of parents or guardians refused to be interviewed, however this non-response is below 10%, the acceptable level compensated for in the adjusted sample size. The findings would be more inclusive if young children (1–4 years) were included in the study, however these children of age range of 5–8 years covered have a higher cumulative probability of acquiring *S. haematobium* infection, hence ideal for establishing infection status among preschool children[9].

Young children excluded in praziquantel preventive chemotherapy harbor *S. haematobium* infection and are likely to be the source of shedding eggs in the environment. The presence favorable ecological conditions for *Bulinus* spp. snails and flourishing of the snails in the surveyed area show the potential for the continuity of *S. haematobium* transmission. This scenario is likely to frustrate national efforts to control schistosomiasis by praziquantel preventive chemotherapy to school children. Larger studies covering infants and under fives are needed to accurately map up the burden of schistosomiasis in preschool children and advice of policy makers for their inclusion in the national praziquantel preventive chemotherapy campaigns.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgments

Special thanks are go to parents or guardians of the Class I pupils for consenting for themselves and on behalf of their children to participate in the study. Thanks are due to the head teachers and class room teachers of the respective schools for supporting the study and make it a success. Special thanks go to the Class I pupils from the respective schools for participating in the study. Thanks are due to the academic staff members from the Muhimbili University of Health and Allied Sciences who in one way or the other made this work that is a part of the master of science in Parasitology & Entomology Degree dissertation become a success. This study received financial support through the Directorate of Postgraduate Education from the

Muhimbili University of Health and Allied Sciences which is funded by the Tanzanian Ministry of Health.

References

[1] Gryseels B. Schistosomiasis. *Infect Dis Clin North Am* 2012; **26**(2): 383-97.

[2] Barsoum RS. Urinary schistosomiasis: review. *J Adv Res* 2013; **4**: 453-9.

[3] Chaula SA, Tarimo DS. Impact of praziquantel mass drug administration campaign on prevalence and intensity of *Schistosoma haemamtobium* among school children in Bahi District, Tanzania. *Tanzan J Health Res* 2014; **16**: 1-8.

[4] World Health Organization. Schistosomiasis: progress report 2001–2011, strategic plan 2012–2020. Geneva: World Health Organization; 2013. [Online] Available from: http://www.who.int/neglected_diseases/resources/9789241503174/en/ [Accessed on 21st September, 2016]

[5] Schistosomiasis: number of people treated worldwide in 2014. *Wkly Epidemiol Rec* 2016; **91**(5): 53-60.

[6] Schistosomiasis: number of people treated worldwide in 2013. *Wkly Epidemiol Rec* 2015; **90**(5): 25-32.

[7] Dabo A, Badawi HM, Bary B, Doumbo OK. Urinary schistosomiasis among preschool-aged children in Sahelian rural communities in Mali. *Parasit Vectors* 2011; **4**: e21.

[8] Stothard JR, Sousa-Figueiredo JC, Betson M, Adriko M, Arinaitwe M, Rowell C, et al. *Schistosoma mansoni* infections in young children: when are schistosome antigens in urine, eggs in stool and antibodies to eggs first detectable? *PLoS Negl Trop Dis* 2011; **5**: e938.

[9] Hodges MH, Paye J, Koroma MM, Nyorkor ED, Fofonah I, Zhang Y. High level of *Schistosoma mansoni* infection in pre-school children in Sierra Leone highlights the need in targeting this age group for praziquantel treatment. *Acta Trop* 2012; **124**(2): 120-5.

[10] Stothard JR, Sousa-Figueiredo JC, Navaratnam AM. Advocacy, policies and practicalities of preventive chemotherapy campaigns for African children with schistosomiasis. *Expert Rev Anti Infect Ther* 2013; **11**(7): 733-52.

[11] Ekpo UF, Oluwole AS, Abe EM, Etta HE, Olamiju F, Mafiana CF. Schistosomiasis in infants and pre-school-aged children in sub-Saharan Africa: implication for control. *Parasitology* 2012; **139**: 835-41.

[12] Stothard JR, Sousa-Figueiredo JC, Betson M, Bustinduy A, Reinhard-Rupp J. Schistosomiasis in African infants and preschool children: let them now be treated! *Trends Parasitol* 2013; **29**(4): 197-205.

[13] Ekpo UF, Laja-Deile A, Oluwole AS, Sam-Wobo SO, Mafiana CF. Urinary schistosomiasis among preschool children in a rural community near Abeokuta, Nigeria. *Parasit Vectors* 2010; **3**: 58.

[14] Person B, Ali SM, A'Kadir FM, Ali JN, Mohammed UA, Mohammed KA, et al. Community knowledge, perceptions, and practices associated with urogenital schistosomiasis among school-aged children in Zanzibar, United Republic of Tanzania. *PLoS Negl Trop Dis* 2016; **10**(7): e0004814.

[15] Mazigo HD, Nuwaha F, Kinung'hi SM, Morona D, Pinot de Moira A, Wilson S, et al. Epidemiology and control of human schistosomiasis in Tanzania. *Parasit Vectors* 2012; **5**: 274.

[16] Gorstein J, Sullivan KM, Parvanta I, Begin F. Indicators and methods for cross-sectional surveys of vitamin and mineral status of populations. Atlanta: The Micronutrient Initiative (Ottawa) and the Centers for Disease Control and Prevention; 2007. [Online] Available from: http://www.who.int/vmnis/toolkit/mcn-micronutrient-surveys.pdf [Accessed on 21st September, 2016]

[17] Brown DS. *Freshwater snails of Africa and their medical importance*. 2nd ed. Boca Raton: CRC Press; 1994.

[18] Brown DS, Kristensen TK. *A field guide to African freshwater snails*. Charlottenlund: Danish Bilharziasis Laboratory; 1989.

[19] Mwakitalu ME, Malecela MN, Mosha FW, Simonsen PE. Urban schistosomiasis and soil transmitted helminthiases in young school children in Dar es Salaam and Tanga, Tanzania, after a decade of anthelminthic intervention. *Acta Trop* 2014; **133**: 35-41.

[20] Mutapi F, Rujeni N, Bourke C, Mitchell K, Appleby L, Nausch N, et al. *Schistosoma haematobium* treatment in 1-5 year old children: safety and efficacy of the antihelminthic drug praziquantel. *PLoS Negl Trop Dis* 2011; **5**: e1143.

[21] Sousa-Figueiredo JC, Betson M, Atuhaire A, Arinaitwe M, Navaratnam AM, Kabatereine NB, et al. Performance and safety of praziquantel for treatment of intestinal schistosomiasis in infants and preschool children. *PLoS Negl Trop Dis* 2012; **6**(10): e1864.

[22] Chu TB, Liao CW, D'Lamini P, Chang PW, Chiu WT, Du WY, et al. Prevalence of *Schistosoma haematobium* infection among inhabitants of Lowveld, Swaziland, an endemic area for the disease. *Trop Biomed* 2010; **27**: 337-42.

[23] Garba A, Barkiré N, Djibo A, Lamine MS, Sofo B, Gouvras AN, et al. Schistosomiasis in infants and preschool-aged children: infection in a single *Schistosoma haematobium* and a mixed *S. haematobium*-S. *mansoni* foci of Niger. *Acta Trop* 2010; **115**: 212-9.

[24] Namwanje H, Kabatereine NB, Olsen A. The acceptability and safety of praziquantel alone and in combination with mebendazole in the treatment of *Schistosoma mansoni* and soil-transmitted helminthiasis in children aged 1-4 years in Uganda. *Parasitology* 2011; **138**(12): 1586-92.

[25] Verani JR, Abudho B, Montgomery SP, Mwinzi PN, Shane HL, Butler SE, et al. Schistosomiasis among young children in Usoma, Kenya. *Am J Trop Med Hyg* 2011; **84**: 787-91.

[26] Bustinduy AL, Parraga IM, Thomas CL, Mungai PL, Mutuku F, Muchiri EM, et al. Impact of polyparasitic infections on anemia and undernutrition among Kenyan children living in a *Schistosoma haematobium*-endemic area. *Am J Trop Med Hyg* 2013; **88**: 433-40.

[27] Webster JP, Koukounari A, Lamberton PH, Stothard JR, Fenwick A. Evaluation and application of potential schistosome-associated morbidity markers within large-scale mass chemotherapy programmes. *Parasitology* 2009; **136**: 1789-99.

[28] Coulibaly JT, N'Gbesso YK, N'Guessan NA, Winkler MS, Utzinger J, N'Goran EK. Epidemiology of schistosomiasis in two high-risk communities of south Cote d'Ivoire with particular emphasis on pre-school-aged children. *Am J Trop Med Hyg* 2013; **89**(1): 32-41.

[29] World Health Organization. Report of a meeting to review the results of studies on the treatment of schistosomiasis in preschool-age children. Geneva: World Health Organization; 2010. [Online] Available from: http://apps.who.int/iris/bitstream/10665/44639/1/9789241501880_eng.pdf [Accessed on 21st September, 2016]

[30] Stothard JR, Sousa-Figueiredo JC, Betson M, Green HK, Seto EY, Garba A, et al. Closing the praziquantel treatment gap: new steps in epidemiological monitoring and control of schistosomiasis in African infants and preschool-aged children. *Parasitology* 2011; **138**(12): 1593-606.

[31] Opisa S, Odiere MR, Jura WG, Karanja DM, Mwinzi PN. Malacological survey and geographical distribution of vector snails for schistosomiasis within informal settlements of Kisumu City, Western Kenya. *Parasit Vectors* 2011; **4**: 226.

[32] Dabo A, Diarra AZ, Machault V, Touré O, Niambélé DS, Kanté A, et al. Urban schistosomiasis and associated determinant factors among school children in Bamako, Mali, West Africa. *Infect Dis Poverty* 2015; **4**: 4.

[33] Knopp S, Stothard JR, Rollinson D, Mohammed KA, Khamis IS, Marti H, et al. From morbidity control to transmission control: time to change tactics against helminths on Unguja Island, Zanzibar. *Acta Trop* 2013; **128**(2): 412-22.

[34] Savioli L, Fenwick A, Rollinson D, Albonico M, Ame SM. An achievable goal: control and elimination of schistosomiasis. *Lancet* 2015; **386**(9995): 739.