ORIGINAL RESEARCH

# INTESTINAL SCHISTOSOMIASIS: PREVALENCE, KNOWLEDGE, ATTITUDE AND PRACTICES AMONG SCHOOL CHILDREN IN AN ENDEMIC AREA OF NORTH WESTERN TANZANIA

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ABSTRACT

Objective: Knowledge, attitudes and preventative practices of risk groups for neglected tropical diseases such as intestinal schistosomiasis are important aspects for their control. This study aimed to determine the prevalence of *Schistosoma mansoni*, knowledge, perceptions and preventative practices of school children towards schistosomiasis in the Sengerema district, Tanzania. Methods: We conducted a cross-sectional study using 400 randomly selected school children. Single faecal specimens were obtained from children and screened for *S. mansoni* using Kato Katz technique. Amongst those children who submitted faecal specimen, 200 randomly selected children responded to a structured questionnaire. Results: The prevalence of *Schistosoma mansoni* was 64.3% (257/400; 95% confidence interval (CI) = 59.3, 69.0). Less than 50% of the interviewed children demonstrated an understanding of control measures and transmission of schistosomiasis. About 87.5% (175/200; 95% CI = 82.1, 91.7) of the respondents reported to have heard of schistosomiasis and the main source of information were schools (34.5 %). 84% of the children reported going to the lake and 68% reported to participate in paddy cultivation. About 40.5% of the respondents associated schistosomiasis with water contact and 39.5% accurately quoted symptoms associated with schistosomiasis. Knowledge about transmission increased with age (p=0.005). The control measures mentioned by 34.5% of the respondents were in line with the World Health Organization's control strategies against schistosomiasis. Most of respondents (96.5%) reported the use of toilets. A majority (82%) of the respondents reported that they had participated in previous mass drug administration. Conclusion: The prevalence of schistosomiasis was high despite repeated previous mass drug administration campaigns. There is a need to incorporate practical public health education in the school curriculum for the purpose of increasing knowledge and promoting behavioral changes in school children to improve disease control.

KEY WORDS: Intestinal schistosomiasis; Prevalence; Attitude; Practice; Knowledge; Public health; Tanzania; Africa.

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## INTRODUCTION

Schistosomiasis is second only to malaria as a parasitic disease of serious public health importance in subtropical and tropical Africa (TDR, 2009). Schistosomiasis is endemic to 76 countries (Crompton *et al*., 2001). Globally, seven hundred and seventy nine million people are at risk of schistosomiasis infection and 193 million are already infected (Chitsulo *et al*., 2000; Steinmann *et al*., 2006). Reasons for the persistence of the disease in spite of prolonged control and preventive efforts include wide distribution of the intermediate host, migration, the dependency of many poor populations in both rural and urban areas on schistosomes-infested water sources for their domestic, occupational and recreational needs, lack of sanitation, portable water and scarcity of and deficiencies in preventive and curative health services (Ximenes *et al*., 1989; WHO, 2001).

In Tanzania, *Schistosoma mansoni* infections are highly endemic in areas surrounding the Lake Victoria basin (Lwambo *et al*., 1999) and the parasite which causes intestinal schistosomiasis if not treated, may have more serious consequences, such as severe hepatomegaly, splenomegaly, hepatosplenomegaly, esophageal varices, bleeding and death (WHO, 2002). In school-aged children schistosomiasis has a detrimental impact on physical, cognitive and intellectual growth as well as causing nutritional deficiencies (Partnership for Child Development, 1997). The cornerstone for the control of schistosomiasis and intestinal nematodes in Tanzania and other endemic African countries are school-based treatment approaches where children receive single doses of praziquantel and mebendazole/albendazole once per year (WHO, 2002). Although chemotherapy can reduce morbidity caused by the infection, rapid re-infection usually occurs in school children, requiring repeated treatment (N'Goran *et al*., 2001). Thus medical intervention alone is insufficient to control the disease. Integrating health education and medical intervention remain a high priority for the World Health Organization's (WHO) control programs. However in many endemic areas control

 
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programs often do not incorporate public health education of the target groups.

Most of the studies conducted on schistosomiasis in the Lake Victoria basin have been focusing on the epidemiology and control of the disease. However, knowledge, perceptions and practices of school children, who are the target group for the control measures, are not well understood (Lwambo *et al*., 1999; Guyatt *et al*., 1999). Obtaining information regarding the perceptions and practices of school children will assist in the planning and implementation of appropriate control measures. This descriptive cross sectional study was conducted to establish *S. mansoni* prevalence in school children living in an endemic area in Tanzania. The study investigated further the school children's knowledge of intestinal schistosomiasis transmission, recognition of signs and symptoms, perceptions of cause, treatment, preventive measures and practices.

## METHODS

### Study design

The study was a cross-sectional survey conducted between April and May 2009 targeting primary school children.

### Study area

The study was conducted in the Nyamatongo ward of Sengerema District, Mwanza Region, north-west Tanzania. The ward borders Lake Victoria to the north and east. Perennial rivers and streams run in the basin towards Lake Victoria. Sandy loam with moderate to good drainage occurs throughout most of the region. Rainfall is seasonal with two rainy seasons, a short season between September and December; and a long rainy season from February to May with annual average rainfall of about 1065mm.Temperature ranges from 25$^0$C to 28$^0$C between September and December and from 11$^0$C to 20$^0$C between June and August.

The main control strategy against schistosomiasis in the study area involves an ongoing school based treatment approach were school children receive single doses of praziquantel (40mg/kg) and 400mg albendazole/mebendazole. According to information obtained from the District Medical Officer's office, school children in the ward received the anthelminthics mebendazole and praziquantel in 2004, 2006 and 2007 as part of the control for schistosomiasis and soil-transmitted helminths through the Tanzania government program with the support of the schistosomiasis initiative control.

### Study population and sampling

The study included years 3 to 7 primary school children attending schools located in the Nyamatongo ward. The ward has a total of 12 primary schools with a total of 3600 school children. The target populations were school children attending primary schools located close to the Lake Victoria shore (approximately 0.5 to 1.5 km from the shore). The topographical map of the ward was divided into 10 squares equal in size and a simple random method was used to select schools to participate in the study from the squares. The schools involved in the study were Irunda, Karumo, Nyalwambu and Kamanga primary schools which had a total of 1600 primary school children. The age of selected children ranged between 8 and 17 years.

Simple random sampling was used to select children to participate in the study (Lwambo *et al*., 1999). Using the attendance registries of the participating schools, each child was given a number and selection of the children to participate in the study was achieved by using tables of random numbers. A total of 400 school children were selected for the parasitological survey. Two hundred (200) school children were selected randomly from the 400 school children by allowing children to pick slips of paper from a covered bucket and these responded to the questionnaires provided by the assistant researcher.

### Parasitological examination and administering questionnaires

Faecal samples were obtained from 400 randomly selected school children using a wide mouth plastic specimen bottles labeled with the laboratory identification number assigned to each child. The samples were processed within an hour of collection. *Schistosoma mansoni* infection was determined using the Kato Katz technique (Katz *et al*., 1972). Briefly, two thick faecal smears were prepared from faecal samples obtained from each child using 41.7mg template and the smears were left to clear for at least 24 hours and were examined to detect *S. mansoni* eggs. The number of eggs detected from each Kato-Katz thick smear was multiplied by 24 in order to express infection intensities as number of eggs per gram of stool. Egg intensities of *S. mansoni* were grouped into the following categories for analysis: light infection (1-100 eggs per gram of stool), moderate (101-399 eggs per gram of stool), heavy (400-1000 eggs per gram of stool) and very heavy (1001 and more eggs per gram of stool (WHO, 1993).

Before the start of the study, a structured questionnaire was developed and pre-tested for ascertaining consistency and appropriateness of language using school children different from the ones who participated in the study. The questionnaire was distributed to 200 children who participated in the study. Demographic data, including age and sex were recorded in the questionnaire. In addition, age of each participant was obtained from the class registers provided by teachers. Questions were asked about the knowledge of intestinal schistosomiasis, its symptoms, transmission, preventive measures and treatment. The first part of the questionnaires had questions on school children's attitudes and understanding of schistosomiasis transmission, recognition of symptoms and signs, as well as perceptions of cause. The third part of the questionnaire assessed the knowledge on preventive measures. The fourth part examined knowledge and perceptions on treatment of intestinal schistosomiasis. Respondents were not prompted with possible answers and multiple answers were allowed for some questions. The questionnaires were translated into Swahili language which is the language for teaching at primary schools and most people in the study area use Swahili for day-to-day communication.

### Data management and analysis

Data entry was done using Microsoft excel (Microsoft Corp., Redmond, WA, USA). Data entry was done in duplicate for validation (double entry). Before analysis, data were cross-checked for entry error and ranges were checked. Data were analyzed using SPSS version 11.5 for Window (SPSS Inc, Chicago, IL, USA). Prevalence of infections and 95% confidence interval (CI) were calculated. Descriptive statistics including percentages and mean values were used to analyze data obtained through questionnaire. Frequencies and percentages were used to present categorical variables. Cross tabulations and Chi-square tests were used to determine dependence between categorical characteristics. P-values less than 0.05 were considered statistically significant.

### Ethical consideration

District medical and education offices, ward education officers, head teachers and village executive officers granted a written permission to conduct the study in their administrative area. General information regarding the nature of the study and its objective was explained to teachers, parents/guardians, and school children. Confidentiality and anonymity was maintained throughout the study period. During analysis only codes were used instead of participants' names. Inclusion of children into study took place only after written and verbal informed consent was received from school authorities and parents. Children joined the study voluntarily and were free to drop out of the study at any time. The response rate was 100%. Ethical clearance was granted by the joint Research and Publication Committee of Bugando Medical Centre and Weill-Bugando University College of Health Science, Tanzania.

Children found infected with *S. mansoni* received a single oral dose of praziquantel at 40mg/kg and those who were infected with soil-transmitted helminths received a single oral dose of mebendazole (400mg) for treatment.

## RESULTS

### Demographic characteristics of the sample

As illustrated in table 1, a total of 400 school children participated in the study and were screened for intestinal schistosomiasis. Of those screened for *S. mansoni*, 204 (51%) were female and 196 (49%) were male. Two hundred (200) children filled out the questionnaires after being screened for *S. mansoni*. Of those who answered the questionnaire, 100 (50%) were males and 100 (50%) were females. The age of children ranged from 8 to 17 years with a mean age of 12.2 years (± 3.3).

### Prevalence of *S. mansoni* in school children

Of the 400 stool specimens examined, *S. mansoni* eggs were found in 64.3% (257/400; 95% CI = 59.3, 69.0) specimens, with no significant difference between female and male students ($P$< 0.313). Out of 257 school children positive for *S. mansoni*, 35.4% (91/257) of them had light infection intensity (Table 2).

### Knowledge, perceptions and preventative practices

Questionnaires were obtained from 200 school children from years 3 to 7 of four primary schools. About 87.5% (175/200; 95% CI = 82.1, 91.7) of respondents reported that they had heard of schistosomiasis. Schools (34.5%) were the main source of information (Table 3).

Table 1: Characteristics of the sample of 400 school children from Tanzania.

| Age (years) | Males | | Females | | Total |
|---|---|---|---|---|---|
| 8-10 | 33 | 39.8% | 50 | 60.2% | 83 |
| 11-13 | 104 | 49.5% | 106 | 50.5% | 210 |
| 14-17 | 59 | 55.1% | 48 | 44.9% | 107 |
| Total | 196 | 49% | 204 | 51% | 400 |

Table 2: *S. mansoni* egg intensity and prevalence (%) stratified by age and sex among 400 school children in the Nyamatongo ward, Tanzania.

| | | Infection Intensity of *S. mansioni* (eggs/g feaces)* | | | | | |
|---|---|---|---|---|---|---|---|
| | | Light | Moderate | Heavy | Very Heavy | Prevalence | 95%-CI** |
| | N | 1-100 N (%) | 101-400 N (%) | 401-1000 N (%) | 1001 + N (%) | % | |
| Gender | | | | | | | |
| Female | 204 | 55 (26.9) | 36 (17.6) | 28 (13.7) | 16 (7.8) | 66.2% | 59.2 – 73.6 |
| Male | 196 | 36 (18.4) | 43 (21.9) | 29 (14.8) | 14 (7.1) | 62.2% | 55.1 – 69.1 |
| Age (years) | | | | | | | |
| 8-10 | 83 | 21 (25.3) | 18 (21.7) | 11 (13.3) | 6 (7.2) | 67.5% | 56.3 – 77.4 |
| 11-13 | 210 | 46 (21.9) | 41 (19.5) | 38 (18.0) | 18 (8.6) | 68.1% | 61.3 – 74.3 |
| 14-17 | 107 | 24 (22.4) | 20 (18.7) | 8 (07.5) | 6 (5.6) | 54.2% | 44.3 – 63.9 |

*Light infection: 1-100 eggs, moderate: 101-399 eggs, heavy: 400-1000 eggs, and very heavy: 1001 and more eggs per gram of stool (WHO, 1993);
**95%-CI = 95% confidence interval.

Table 3: Primary source of information about schistosomiasis for 200 school children in Tanzania.

| Source of information about Schistosomiasis | Frequencies (n) | Percent | 95%CI |
|---|---|---|---|
| School | 69 | 34.5% | 27.9 - 41.5 |
| Home | 50 | 25.0% | 19.2 - 31.6 |
| Radio | 14 | 7.0% | 3.9 - 11.5 |
| Hospital & home & school &health center | 43 | 21.5% | 16.0 – 27.9 |
| Other sources | 24 | 12.0% | 7.8 - 17.3 |



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About 20.5% (41/200) of the respondents reported correctly that worms are the cause of the disease although few of them were able to mention the species of the worm (Table 4). A majority of the respondents 65.5% (131/200) reported to know only schistosomiasis haematobium (Table 4). A higher proportion of males (45%) than females (36%) were able to correctly name the cause of schistosomiasis, however, the difference was not significant (p= 0.060).

The symptoms to which respondents referred varied considerably and symptoms usually not associated with schistosomiasis were also reported (Table 4). There was confusion relating to the different symptoms of *S. mansoni* and *S. haematobium*. There was no significant difference between males and females in providing correct answers (35% versus 31%, p=0.512). About 5.5% (11/200) of the respondents reported swimming in dirty water (water contact) as a mode of transmission of disease. The 14 to 17 year olds (59%) were more likely to give correct answers compared to the younger age group (22%; p<0.001). Ten percent (20/200) of the respondents reported correctly that lakes and rice fields to be the risk areas where one can get schistosomiasis (Table 4).

Table 4: Knowledge and perceptions about schistosomiasis. Results were based on 200 school children from Tanzania.

| | Frequencies | Percent (%) | 95% CI |
|---|---|---|---|
| Knowledge on the cause of schistosomiasis | | | |
| Worms | 41 | 20.5 | 15.1 - 26.8 |
| Dirty water | 54 | 27.0 | 21.0 - 33.7 |
| Swimming in lakes | 14 | 7.0 | 3.9 - 11.5 |
| Drinking dirty water | 13 | 6.5 | 3.5 - 10.9 |
| Other causes | 36 | 18.0 | 12.9 - 24.0 |
| Don't know | 42 | 21.0 | 15.6 - 27.3 |
| Knowledge about the types of schistosomiasis | | | |
| *Schistosoma mansoni* | 39 | 19.5 | 14.3 - 25.7 |
| *Schistosoma haematobium* | 131 | 65.5 | 58.5 - 72.1 |
| Don't know | 30 | 15.0 | 10.4 - 20.7 |
| Knowledge about symptoms and signs of schistosomiasis | | | |
| Abdominal pain | 13 | 6.5 | 3.5 - 10.9 |
| Haematuria | 30 | 15.0 | 10.4 - 20.7 |
| Pain during micturition & | 6 | 3.0 | 1.1 - 6.4 |
| Abdominal pain & | 36 | 18.0 | 12.9 - 24.0 |
| Swelling of the abdomen &Dysentery & haematuria | 21 | 10.5 | 6.6 - 15.6 |
| Other signs and symptoms | 41 | 20.5 | 15.1 - 26.8 |
| Don't know | 53 | 26.5 | 20.5 - 33.2 |
| Knowledge about schistosomiasis transmission | | | |
| Swimming in dirty water | 11 | 5.5 | 2.8 - 9.6 |
| Urinating & defecating in | 42 | 21.0 | 15.6 - 27.3 |
| Stepping over human feaces | 33 | 16.5 | 11.6 - 22.4 |
| Snails | 1 | 0.5 | 0.01 - 2.8 |
| Other ways of transmission | 41 | 20.5 | 15.1 - 26.8 |
| Don't know | 72 | 36.0 | 29.4 - 43.1 |
| Knowledge about areas one can get infected with schistosomiasis | | | |
| Lakes | 13 | 6.5 | 3.5 - 10.9 |
| Rivers | 18 | 9.0 | 5.4 - 13.9 |
| Rice fields | 14 | 7.0 | 3.9 - 11.5 |
| Water collection areas | 23 | 11.5 | 7.4 - 16.8 |
| Toilets | 20 | 10.0 | 6.2 - 15.0 |
| Lake & rice fields | 40 | 20.0 | 14.7 - 26.2 |
| Lake & rivers | 13 | 6.5 | 3.5 - 10.9 |
| Lake & rivers & rice fields | 15 | 7.5 | 4.3 - 12.1 |
| Other areas | 14 | 7.0 | 3.9 - 11.5 |
| Don't know | 43 | 21.5 | 16.0 - 27.9 |



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About 36.5% of all 200 children who responded to the questionnaire reported correctly that avoiding swimming in water and avoiding urinating and defecating in lakes as key control measures against schistosomiasis. The older the participating children the more likely they were to give correct answers (8-10 years: 23%; 11-13 years: 33%; 14-17 years: 44%; p= 0.009). There was no gender-related difference (p=0.623). Other control measures were presented in Table 5.

Of all respondents, 96.5% of school children reported to use toilets at home and at school. However 3.5% (7/200) of them did not use toilets and reported to defecate in lakes and in the forest. Reasons given for using toilets were to control diseases such schistosomiasis (39.5%) and to reduce the spread of diseases (32.5%) (Table 5). Overall, 84% of the children reported going to the lake and 68% reported to participate in paddy (*Oryza sativa*) cultivation (Table 5). A significantly higher proportion of males (83.3%) than females (16.7%) reported to participate in fishing (p<0.001).

Overall, 91% (182/200) of the respondents believed that schistosomiasis can be treated and 82% (164/200) of the respondents had received anthelminthics mebendazole and praziquantel during the mass drug administration (MDA) campaigns in 2004, 2006 and 2007. When asked if they were willing to take anti-schistosomes, 88% (176/200) of the respondent were willing. Medical doctors were identified by many of the respondents as a person who can treat schistosomiasis and the hospital was identified as the place one can receive treatment (Table 6).

Table 5: Knowledge about preventive and control measures of schistosomiasis. Results were based on 200 school children from Tanzania.

| | Frequencies | Percent (%) | 95%-CI* |
|---|---|---|---|
| Preventive and control measures | | | |
| *Control measures against schistosomiasis* | | | |
| Avoid swimming in lakes | 27 | 13.5 | 9.1 – 19.0 |
| Taking drugs & wearing shoes | 32 | 16 | 11.2 – 21.8 |
| Use of toilets | 13 | 6.5 | 3.5 - 10.9 |
| Avoid urinating & defecating in lakes | 23 | 11.5 | 7.4 -16.8 |
| Other | 27 | 13.5 | 9.1 – 19.0 |
| Don't know | 78 | 39 | 32.2 – 46.1 |
| *Use of toilets at home and at school* | | | |
| Yes | 193 | 96.5 | 92.2 – 98.6 |
| *Areas where children defecate* | | | |
| Toilets | 196 | 96.5 | 95.0 – 99.5 |
| In lakes | 3 | 1.5 | 0.3 – 4.3 |
| In forest | 4 | 2 | 0.06 – 5.0 |
| *Information on the importance of using toilets* | | | |
| To control diseases such as schistosomiasis | 79 | 39.5 | 32.7 - 46.6 |
| To reduce spread of diseases | 65 | 32.5 | 26.1 – 39.5 |
| To prevent environment contaminations | 22 | 11 | 7.0 – 16.2 |
| Others | 4 | 2 | 0.06 – 5.0 |
| Don't know | 30 | 15 | 10.4 – 20.7 |
| Risky activities of children | | | |
| *Going to the lakes* | | | |
| Yes | 168 | 84 | 78.2 – 88.8 |
| *Reasons for going to the lake* | | | |
| Fetching water | 39 | 19.5 | 14.3 – 25.7 |
| Fishing | 12 | 6 | 3.1 – 10.3 |
| Washing clothes | 18 | 9 | 5.4 -13.9 |
| Swimming | 20 | 10 | 6.2 -15.0 |
| Fetching water & washing | 37 | 18.5 | 13.4 – 24.6 |
| Washing clothes & fetching | 16 | 8 | 4.6 – 12.7 |
| Others | 27 | 13.5 | 9.1 – 19.0 |
| Don't go to the lake | 31 | 15.5 | 10.8 – 21.3 |
| *Participating in paddy cultivations (n= 200)* | | | |
| Yes | 136 | 68 | 61.1 - 74.4 |

*95%-CI = 95% confidence interval



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Table 6: Information regarding treatment of schistosomiasis. Results were based on 200 school children from Tanzania.

| | Frequencies | Percent (%) | 95%-CI* |
|---|---|---|---|
| Schistosomiasis can be treated | | | |
| Yes | 182 | 91 | 86.2 – 94.6 |
| Participation in school mass drug administration | | | |
| Yes | 164 | 82 | 76.0 - 87.1 |
| Willing to take anti-schistosomes during mass drug administration at school | | | |
| Yes | 176 | 88 | 82.7 – 92.2 |
| Person can treat schistosomiasis | | | |
| Doctor | 146 | 73 | 66.3 - 79.0 |
| Teachers | 12 | 6 | 3.1 – 10.3 |
| Doctor + nurses | 15 | 7.5 | 4.3 – 12.1 |
| Teachers + nurses + parents | 16 | 8 | 4.6 – 12.7 |
| Others | 2 | 1 | 0.1 – 3.6 |
| Don't know | 9 | 4.5 | 2.1 – 8.4 |
| Areas to get treatment against schistosomiasis | | | |
| Hospital | 137 | 68.5 | 61.6 – 74.9 |
| Health center | 17 | 8.5 | 5.0 – 13.3 |
| School | 14 | 7.0 | 3.9 - 11.5 |
| Health + hospital + school | 19 | 9.5 | 5.8 -14.4 |
| Others | 3 | 1.5 | 0.3 – 4.3 |
| Don't know | 10 | 5 | 2.4 – 9.0 |

*95%-CI = 95% confidence interval

## DISCUSSION

The present study of a cross-section of school children from Tanzania demonstrated a level of knowledge of intestinal schistosomiasis aetiology, symptoms, treatment and preventive methods, similar to other study areas (Sow et *al*., 2003; Mekheimar and Talaat, 2005). The results showed that most children had heard of schistosomiasis and the most important source of information was the school. Results were similar to a report from Brazil where school was also reported as a main source of information about schistosomiasis (Uchuo *et al*., 2000). None of the children mentioned the posters about schistosomiasis provided by the Ministry of Health and Social Welfare of Tanzania as a source of information. One can only speculate that the poster message might not have been targeted appropriately to the age group. Similarly, in Senegal poster and billboard messages did not influence community perceptions about schistosomiasis (Sow *et al*., 2003). Other respondents acknowledged that information about schistosomiasis was conveyed to them through family members (home), hospitals and health centers. This indicated that community and social organizations may act as good intermediaries to deliver health education messages (Sow *et al*., 2003). School teachers should receive health education training in school programmes and through community infrastructure.

In this study, a proportion of the respondents made the correct association between schistosomiasis and water contact, but their understanding of the mechanism of transmission was insufficient. The modes of transmission identified by respondents were swimming, defecating and urinating in water sources yet this did not prevent 84% of the respondents to coming into contact with lake water. This is in line with the observations in previous studies from Egypt (Mekheimar and Talaat, 2005) and Zimbabwe (Ndamba *et al*., 1989). To achieve maximum control of schistosomiasis, improvement of socio-economic status and hygiene seem to be required. Provision of safe tap water or pumped water is urgently needed in endemic areas. Furthermore, improvement of preventive and curative health services shouldl help to control the disease.

Observations regarding signs and symptoms of schistosomiasis showed that almost 40 percent of the respondents reported symptoms of schistosomiasis correctly. This result is again similar to previous studies (Mekheimar and Talaat, 2005). A majority of symptoms mentioned by the children were associated with urinary schistosomiasis and only few mentioned symptoms associated with intestinal schistosomiasis; confirming previous findings from Tanzania (Guyatt *et al*., 1999; Mwanga *et al*., 2004).

The present study found that a majority of the children knew the areas where transmission of schistosomiasis could take place. Interestingly, some children reported toilets to be the source of transmission. This may be due to confusion with hookworm and other soil-transmitted helminths campaign. In contrast, children from Senegal reported the presence of garbage or flies to be associated with transmission (Sow *et al*., 2003). Poor knowledge about the sources of transmission amongst children must be a source of concern, as in this group water contact as well as infection rates are generally highest (Schall, 1987).

Several of the control measures described by the participants were similar to current public health recommendations for preventing schistosomiasis. Since, the transmission of the disease was associated with water sources, a majority of the respondents reported avoiding contact with water from lakes and using toilets

 
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to be the key preventive and control measures against schistosomiasis. Interestingly, only 10.5% reported drugs to be a preventive measure despite the fact that most of the respondents had received anthelminthics during previous mass drug administration (MDA) campaigns in 2004, 2006 and 2007. Little knowledge about chemotherapy among the risk groups were also reported from Brazil (Gazzinelli *et al*., 1998) where it was suggested that locals believed that young children who did not take any antischistosomes up to the age of 7 years will never get infected.

The study found that 3.5% of respondents never defecate in toilets but in lakes and in the forest. This practice allows helminth eggs from the feaces of infected persons to contaminate the environment including water sources. The results of our study were similar to those reported from Thailand (Anantaphruti *et al*., 2004). The reasons given for defecating in toilets were mainly to control diseases such as schistosomiasis and to reduce the spread of diseases. These reasons were similar to current public health recommendations for preventing and controlling schistosomiasis reported elsewhere (Gazzinelli *et al*., 2006).

In the present study, 82% of the children reported that they had participated in school based mass drug administration against schistosomiasis in 2004, 2006 and 2007. The results were higher than the 65.7% reported from Thailand (Anantaphruti *et al*., 2004). Despite this high participation rate amongst school children, the prevalence of *S. mansoni* (64.3%) was above the WHO recommendations for MDA campaigns. WHO recommends MDA against schistosomiasis in school children when the prevalence is above 50%. The high prevalence of schistosomiasis despite several MDA campaigns is likely due to the unchanged behavior of the children. Some respondents were unwilling to take the anthelminthics and, although the present study did not include respective questions, it has been suggested by older school children (years six and seven; 14 to 17 years) that the drugs may affect their reproductive ability.

The present study also confirmed that *S. mansoni* was still a problem in areas surrounding Lake Victoria (Ajanga *et al*., 2006). The prevalence of *S. mansoni* observed in school children in the present study was higher than in previous reports from Tanzania (Lwambo *et al*., 1999) and Kenya (Booth *et al*., 2004). These variable results might be a reflection of the local endemicity, varying sanitary standards, environmental conditions, personal hygiene (Booth *et al*., 2004) and micro-geographical variations in exposure to *S. mansoni* by the populations living in these endemic areas (Uchuo *et al*., 2000). The present study investigated a relatively small sample of children and these children may not be a complete representation of all the school children within the community. Irrespectively, the high number of respondents who failed to understand basic concepts of schistosomiasis is of concern and warrants immediate attention. Further investigations about knowledge, attitudes and preventive practices against other helminth infections, which are highly endemic in the current study area, are warranted.

In conclusion, the present study showed that, despite sustained control efforts and intensive research actions, prevalence of schistosomiasis was high and there was still a lack of understanding concerning schistosomiasis in many of the school children from the Sengerema district of Tanzania. Thus, combined efforts from the community, education, and health sectors are urgently needed to identify the factors which led to the apparent failure and to come up with participatory approaches which will involve all stakeholders. Although health education by itself cannot guarantee the control of schistosomiasis, it is a fundamental starting point around which other measures can be built to create a favourable environment for the promotion of higher levels of health consciousness and more critical thinking towards improving the quality of life of endemic communities.

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