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Prevalence of *Schistosoma mansoni* and soil transmitted helminths and factors associated with uptake of preventive chemotherapy among school children in Sengerema District in north-western Tanzania

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Abstract
Background: The control of intestinal schistosomiasis and soil transmitted helminths (STH) in Tanzania focuses on reducing morbidities through the treatment of infected and at risk populations, especially schoolchildren with praziquantel (PZQ) and albendazole (ALB). However, in some areas, the uptake of interventions is low. The objective of this study was to determine factors associated with the uptake of preventive chemotherapy and, secondarily, the prevalence of *Schistosoma mansoni* and soil-transmitted helminths' infections in Sengerema District of north western Tanzania.
Methods: This cross-sectional study was conducted among 625 randomly selected school children aged 8-18 years from Sengerema district. A questionnaire was used to collect information on the reported uptake of PZQ/ALB. Single stool samples were collected, processed and examined for the presence of eggs pf *S. mansoni* and soil-transmitted helminths using Kato Katz technique.
Results: The self-reported uptake of preventive chemotherapy was 95.6% (95%CI; 92.78-98.49). Provision of food (AOR= 25.25, 95%CI: 5.28-120.49, $p<0.001$) and information about the anti-helminthic drug prior to taking it (AOR =14.24, 95%CI: 3.23-62.72, $p<0.001$) were associated with a high reported uptake of preventive chemotherapy. The overall prevalence of *S. mansoni* and geometrical mean of eggs per gram (EPG) of faeces were 36.64% (95%CI: 21.55 -62.29) and 229.47 EPG (202.73-259.86). The prevalence of STH was 10.88% (95%CI; 7.52-15.75).
Conclusion: The high reported uptake of preventive chemotherapy was associated with provision of food and information about the drugs prior to their administration. However, *S. mansoni* and soil-transmitted infections are still a public health concern in the study area. Integrating health education in mass drug administration campaigns will allow provision of other complementary public preventive measures to reduce the burden of these infections.

Keywords: preventive chemotherapy, uptake, *Schistosoma mansoni*, soil-transmitted helminths, Tanzania

Introduction

Tanzania is the second country after Nigeria for harbouring the highest numbers of cases of schistosomiasis in Sub-Saharan Africa (Chitsulo *et al.,* 2000). An approximated 51.5% of the Tanzanian population is infected or at risk of being infected with schistosomiasis (Mazigo *et al.*, 2012; Rollinson *et al.*, 2013). Soil-transmitted helminths (STHs) are also endemic to the country and the prevalence of these infections varies significantly from one epidemiological setting to another (Lwambo *et al.*, 1999, 2000; Mazigo *et al.*, 2010a; Mboera *et al.,* 2011). These infections often are co-endemic and co-infection does occur, especially in highly endemic communities (Lwambo *et al.*, 1999; Mazigo *et al.*, 2010a; Mboera *et al.,* 2011). In the country, school aged children carry the largest burden of the infection and among them, few are heavily infected while the majority carry light and moderate infection intensities (Lwambo *et al.*, 1999, 2000; Mazigo *et al.*, 2010a,b). In this age group, the infection with intestinal schistosomiasis and STHs is associated with significant morbidities (Lwambo *et al.*, 1999; Mazigo *et al.*, 2012; El Scehich *et al.,* 2012). A chronic infection with intestinal schistosomiasis and STHs has a detrimental impact on physical, cognitive and intellectual growth, as well as causing nutritional deficiencies (Lwambo *et al.*, 2000;

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Albonico *et al.*, 2008). Along the Lake Victoria shores in north-western Tanzania, evidence indicates that the prevalence of *S. mansoni* in school aged children, depending on the geographical location, ranges from 40% to 100% (Mazigo *et al.*, 2010b,c, 2012).

For the control of schistosomiasis and STHs, especially in infected individuals or groups at risk, Tanzania follows the guidelines of the World Health Organization, which recommend the use of praziquantel (PZQ) and albendazole(ALB)/mebendazole (MEB) (WHO, 2002, 2012; Albonico *et al.*, 2008). Based on the WHO recommendations, PZQ is given once annually and ALB/MEB are given at least twice per year (WHO, 2002, 2012). The recommendations also require a minimum coverage of 75% - 80% of all schoolchildren by mass drug administration (MDA) programmes by 2015 (WHO, 2002,2012). Several approaches are being used to distribute PZQ and ALB/MEB drugs to endemic communities in the country (WHO, 2002; Massa *et al.*, 2009a). School-based mass drug administration targeting school going children is commonly used (Fenwick, 2006; Massa *et al.*, 2009a,b). Though the drugs are distributed for free, the uptake of preventive treatment does not reach the WHO targets (Mafe *et al.,* 2005; Parker *et al.,* 2008; Packer & Allen, 2011; Dabo *et al.*, 2013). Several factors have been described to account for the high and low uptake of preventive chemotherapy (Mafe *et al.,* 2005; Allen & Parker, 2012; Dabo *et al.*, 2013;Muhumuza *et al.*, 2013). The low uptake of preventive chemotherapy, especially among school aged children, has a serious consequences and may result into an increased prevalence and intensity of infection and severe chronic morbidities (Lwambo *et al.*, 2000; Albonico *et al.*, 2008;Parker *et al.*, 2008; El Scheich *et al.*, 2012).

The north-western regions of Tanzania, around the Lake Victoria have been the major focus for MDA to control intestinal schistosomiasis and soil-transmitted helminths in school going children (MoHSW, 2009). Schoolchildren of this area have received continuous treatment for the past five years. However, the level of uptake of preventive chemotherapy and its impact on the diseases' prevalence and infection intensity among schoolchildren have not been evaluated. The objective of this study was to determine the prevalence of *Schistosoma mansoni* and soil-transmitted helminths and factors associated with the uptake of preventive treatment against the parasite among schoolchildren in Sengerema district in north-western Tanzania.

Materials and Methods

Study area

This study was carried out in Sengerema district in Mwanza region of north-western Tanzania. Nyamatongo ward and Kome Island were the area of interest of this study. Nyamatongo ward is bordered by Lake Victoria on the north and west. According to the 2002 census, the population of Nyamatongo was 21,262 people. The ward has five villages, namely Kamanga, Karumo, Nyamatongo, Irunda and Nyalwanda. Each village has a government-owned primary school. Kome Island is inhabited by approximately 40,000 people. The island has ten government-owned primary schools. In the study area, the main economic activities are farming, livestock keeping, small scale business and fishing. Perennial rivers and streams run in the basin towards Lake Victoria. Rainfall is seasonal with two rainy seasons, a short season between September and December and long season from February to May with an annual average rainfall of about 1,065mm. Temperatures range from 25^{o}C to 28^{o}C. The National schistosomiasis and soil transmitted programme introduced mass drug administration for schoolchildren and community members in Nyamatongo from 2004-2011 and Kome Island from 2009-2012. In this programme, schoolchildren receive a single dose of praziquantel 400mg/kg and mebendazole/albendazole 400mg every year.

Study design and population

This was a cross-sectional study conducted among primary schoolchildren who lived and attended selected schools at Nyamatongo and Kome wards. Schoolchildren were included in the

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study if: (i) they were aged 8-18 years; (ii) they were in grade three to six and (iii) parents/guardians provided a written informed consent for their children to participate in the study. Simple random sampling was used to select children to participate in the study. By using the attendance register, each child was given a number and selection was done by using a table of random numbers. The sampling interval was obtained by dividing the total population in the class with the number of children who studied in the class (N/n). The topographical map of Nyamatongo ward and Nkome Island was divided in 10 squares equal in size and schools were selected from each square. For the purpose of the present study, five of the primary schools near and close to the lake shore were randomly selected.

Data collection

Face to face interviews using a structured questionnaire with open and closed questions were conducted to collect data from each child. The questionnaire also collected information on the reported uptake of preventive chemotherapy. A single stool sample was collected from all study participants. Two Kato Katz thick smears were prepared from different parts of the single stool sample using a template of 41.7 mg (Vestergard Frandsen, Lausanne, Switzerland), following a standard protocol (Katz *et al.*, 1972). Within 30-60 minutes of slides' preparation, the Kato Katz smears were examined for the presence of soil-transmitted helminth eggs, specifically hookworms. After 24 hours, the smears were independently examined for *S. mansoni* eggs by two experienced laboratory technicians (Katz *et al.*, 1972). For quality assurance, a random sample of 10% of the negative and positive Kato Katz thick smears were re-examined by a third laboratory technician.

Data analysis

The data were double entered using CSPro and the final data set was stored in a MySQL database. Data analysis was performed using Stata version 12 (Stata Corp, College station, Texas, USA). Mean and standard deviation (S.D) were used to describe continuous data. The prevalence of uptake of preventive chemotherapy, *S. mansoni* and STH with 95% confidence interval (95% CI) was obtained by binomial logistic regression. Comparisons of frequency of uptake of preventive chemotherapy or prevalence of *S. mansoni* by demographic factors were tested for significance using χ^2 or Fisher exact test where appropriate. The arithmetic mean of *S. mansoni* egg counts was calculated from the counts of two Kato Katz thick smears and multiplied by 24 to obtain individuals eggs per gram of faeces. *S. mansoni* eggs counts were over dispersed so were logarithmically transformed prior to analysis. The geometric mean intensity eggs per gram of faeces (GM-epg) of *S. mansoni* infection were obtained as the antilog of the mean of the transformed eggs' counts. Comparisons of geometric mean eggs' counts for *S. mansoni* between various demographic factors were compared using t-test and ANOVA.

Bivariate analysis of the various variables was carried out to identify the factors associated with the uptake of praziquantel using crude odds ratios (COR) and their 95% confidence interval (CI). Multivariable logistic regression was done to identify the independent predictors of the uptake of praziquantel. Missing data was checked for by comparing variables between the subjects with missing data and those with complete data and there were no significant differences. A p –value lower than 0.05 was considered as statistically significant.

Ethical consideration

Ethical approval was obtained from the joint Ethical and Review Committee of Bugando Medical Centre and Catholic University of Health and Allied Sciences. The study received permission from the district and division administrative authorities. Kiswahili translated informed consent forms were used to obtain parents/guardians consent for the children to participate in the study and assent of the children. For illiterate parents, a thumb print was used to sign the consent forms after a clear description of the study objectives and their acceptance for their children to

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participate. All study participants who were infected with *S. mansoni* and STH were treated with praziquantel (40mg/kg) and albendazole (400mg) according to WHO guidelines and country guidelines (WHO, 2002).

Results

Demographic characteristics of study participants

Five schools, namely Irunda, Isenyi, Kabaganga, Nyakasasa and Nyalwambo, were involved in this study. A total of 625 school children were interviewed and screened for *S. mansoni* and STHs (hookworm, *Trichuris trichiura*, *Ascaris lumbricoides* and *Enterobius vermicularis*). Of these children, 324(51.8%) were females and 301(48.1%) were males. The mean age of the study participants was 12.08 ± 1.62 years old, for female mean age was 11.78 ± 1.46 years old and for males 12.39 ± 1.71years old.

Table 1: Respondents reported uptake of preventive chemotherapy among school children

Variable	Response	Uptake of chemotherapy (%)		*P* –value
		Yes	No	
Sex	Female	304 (95.9)	13 (4.1)	
	Male	282 (95.3)	14 (4.7)	0.705
Age	8 -12	349 (96.4)	237 (94.8)	
	13 -18	14 (3.8)	13 (5.20)	0.705
School	Irunda	86 (91.5)	8 (8.5)	
	Isenyi	138 (97.2)	4 (2.8)	
	Kabaganga	117 (100)	0.00	0.003**
	Nyakasasa	143 (95.9)	6 (4.0)	
	Nyalwambo	102 (91.9)	9 (8.1)	
Class	Three	133 (98.5)	2 (1.5)	
	Four	203 (93.5)	14 (6.5)	0.025**
	Five	183 (97.3)	5 (2.6)	
	Six	65 (91.5)	6 (8.4)	
Ward	Kome	281 (96.5)	10 (3.4)	
	Nyamatongo	305 (94.7)	17 (5.3)	0.267

Reported uptake of preventive chemotherapy

The overall uptake of preventive chemotherapy was 95.6%, which varied with the school which the children were attending ($p<0.003$) and the classes ($p<0.025$) (Table 1). In general, the prevalence of reported uptake of preventive chemotherapy varied only by school, with schools located in the Kome Island having significantly higher uptakes.

Table 2: Overall prevalence of *S. mansoni* in relation to social demographic factors and reported uptake of preventive chemotherapy

Variable	Response	Frequency (n)	Prevalence (%)	95% CI	*P*-value
Overall		229	36.6	21.55 – 62.29	
Sex	Female	126	38.9	20.60 – 73.40	
	Male	103	34.2	21.65 – 54.08	0.23
Age	8 – 12	133	35.7	19.21 – 66.54	
	13 – 18	96	37.9	23.04 – 62.50	0.58
School	Irunda	19	18.6	12.66- 27.41	
	Isenyi	82	57.4	56.20 -58.50	
	Kabaganga	68	57.6	43.28 – 76.73	< 0.001
	Nyakasasa	20	13.2	3.14 – 5.57	
	Nyalwambo	40	36.0	21.69 – 59.86	
Reported treatment	No	11	28.2	22.13 – 35.94	
	Yes	218	37.2	21.65 – 63.93	0.26

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Prevalence and intensity of S. mansoni* and STH *infections

The overall prevalence of *S. mansoni* was 36.64 % (95%CI: 21.55- 62.29). The prevalence of *S. mansoni* did not vary by sex, females had a prevalence of 38.89% and males had a prevalence of 34.22% (*P*= 0.23). Similarly, the prevalence of *S. mansoni* did not vary by age groups (*P*=0.27) (Table 2). The prevalence of *S. mansoni* varied significantly with the schools which children were attending (*P* <0.001). Kome Island' schools had a higher prevalence compared to the ones in Nyamatongo (mainland), despite being located along the Lake Victoria shore. Also, the prevalence of *S. mansoni* did not vary by the reported uptake of praziquantel/Albendazole (*P*=0.26).

Table 3: Intensity of *Schistosoma mansoni* in relation to demographic factors

Variable	Response	Frequency (no)	GM (epg)	95%CI	*P* – value
Overall		229	229.47	202.73 -259.86	
Sex	Female	129	245.25	207.29 -290.16	
	Male	109	211.54	175.51 -254.97	0.20*
Age	8 -12	133	248.71	210.70 -293.56	
	13 -18	96	205.25	169.91 -247.94	0.18*
School	Irunda	19	150.09	113.67 -198.21	
	Isenyi	82	173.09	143.57 -210.73	
	Kabaganga	68	401.92	317.23 -509.21	0.0001**
	Nyakasasa	20	217.38	126.46 – 373.68	
	Nyalwambo	40	196.96	157.29 -244.97	
Reported up-take	No	11	140.91	86.43 -229.72	
	Yes	218	235.18	206.89 – 267.34	0.01

** *P*-value by t-test and ***ANOVA, GMepg=Geometrical Mean egg/gram of faeces)

The distribution of geometrical mean egg per gram of faeces (Gm–epg) did not vary by most of the demographic characteristics except for the school where children attending (*p*<0.0001) (Table 3). The prevalence of hookworm was 10.24%, (95% CI: 6.79 -15.42), *Ascaris lumbricoides* was 0.16%, *Trichuris trichiura* was 0.48% and that of *Enterobius vermicularis* was 0.16%. The overall prevalence of any soil-transmitted helminth did not vary by most of the demographic characteristics of the school children.

Table 4: Multivariable table showing factors predicting uptake of preventive chemotherapy

Variable	Response	OR	95%CI	*P*-value	AOR	95%CI	*P*-value
Sex	Female	1			1		
	Male	0.86	0.39-1.86	0.71	1.01	0.22-4.69	0.99
Age	8 – 12				1		
	13 -18	0.73	0.33-1.58	0.43	0.63	0.15-2.56	0.51
School	Irunda	1			1		
	Isenyi	3.21	0.94-10.98	0.06	0.19	0.019-1.81	0.15
	Nyakasasa		0.74-6.61	0.15	0.23	0.03-1.94	0.18
	Nyalwambo		0.38-2.85	0.92	0.80	0.08-8.45	0.56
Provision of food	No	1			1		
	Yes	49.59	15.86-155.07	0.000	25.25	5.28-120.49	0.001
Knowledge of the parasites	No	1		0.07	1		0.86
	Yes	2.31	0.95-5.65		0.84	0.11-6.23	
Given information prior taking of dug	No	1		0.000	1		0.001
	Yes	15.61	5.91-41.24		14.24	3.23-62.72	
Reported side effect	No	1			1		
	Yes	8.01	1.07-60.16	0.043	5.56	0.55-56.66	0.15

cOR =Crude Odd Ratio; AOR=Adjusted Odd Ratio

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Factors associated with the uptake of preventive treatment

On bivariate analysis, the factors associated with the uptake of preventive chemotherapy were provision of food prior to taking the drugs, giving the information prior of taking the drugs and reported side effects. On multivariable analysis, the factors associated with the uptake where only provision of food (AOR=25.25, 95%CI: 5.28-120.49, p<0.001) and giving information about the drug prior of taking the drug (AOR =14.24, 95%CI: 3.23-62.72, p<0.001) (Table 4).

Discussion

The self-reported uptake of preventive chemotherapy in the present study was higher than the WHO requirements (WHO, 2002). A similarly high reported uptake of preventive chemotherapy against schistosomiasis and soil-transmitted helminths was recorded among schoolchildren in the same area in 2010 (Mazigo *et al.*, 2010c). Equally, the self-reported uptake of preventive chemotherapy recorded in the present study was higher than that reported among schoolchildren in Uganda and Nigeria (Mafee *et al.,* 2005; Muhumuza *et al.*, 2013). A comparatively higher uptake of preventive chemotherapy among schoolchildren was reported from Sierra Leone (Hodges *et al.*, 2012). The reported high uptake of preventive chemotherapy recorded in the present study could in part be explained by the fact that the study areas had been under intensive mass drug administration against schistosomiasis and soil-transmitted helminths for the past five years.

In schistosomiasis and soil-transmitted helminth endemic areas, several factors have been described to influence either positively or negatively the uptake of preventive chemotherapy among schoolchildren (Parker *et al*.., 2008; Parker & Allen, 2011; Parker, 2011; Dabo *et al.*, 2013; Muhumuza *et al*., 2013). These factors affecting the uptake of preventive chemotherapy include fear of side effect of drugs, perceived misconception on the safety of drugs, lack of knowledge of preventive measures, ineffective communication about the rationale of MDA; deliberate absenteeism from school during the treatment day and lack of teachers support (Parker *et al.,* 2008; Parker & Allen, 2011; Allen & Parker, 2011; Dabo *et al.*, 2013; Muhumuza *et al.*, 2013). To increase the uptake of preventive chemotherapy among the schoolchildren, these factors must be addressed.

To mitigate the side effects of PZQ, provision of food prior to taking drugs has been recommended (Muhumuza *et al.*, 2014). In the present study, reported provision of food prior to treatment and giving information about the drugs and the aims of the treatment remained significantly associated with the reported uptake of preventive treatment. A recent study in Uganda has shown that the provision of snacks prior to treatment resulted in a higher uptake of preventive chemotherapy (Muhumuza *et al.,* 2014). Similarly, the occurrence of side effects was lower in the schools which received snacks compared to schools which did not receive snacks (Muhumuza *et al.*, 2014). In the present study, receiving information prior to taking drugs was associated with a higher uptake of preventive chemotherapy. Our findings corroborated those of Muhumuza *et al.* (2014) in Uganda. A high rate of uptake of preventive chemotherapy was reported by the control programme in Sierra Leone where provision of food to children prior to treatment was part of the programme (Hodges *et al.*, 2012) . Thus, provision of food and information about the treatment programme and the drugs not only improve the uptake of preventive chemotherapy among school children but also reduce the side effects associated with the drug. In addition, a higher uptake of preventive chemotherapy results into a significant reduction of the prevalence and intensity of *S. mansoni* infection. This combined approach should be adopted by the National Control Programs in endemic areas of Sub-Saharan Africa.

In the present study, the overall prevalence of *S. mansoni* and intensity of infection were lower compared to the results of previous studies in the same area (Lwambo *et al.*, 1999; Mazigo *et al.*, 2010b; El Scheich *et al.*, 2012). The observed lower prevalence and intensity of *S. mansoni* infection in the present study areas could in part be explained as a result of the mass drug

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administration programme which was implemented in the study area during 2008-2012 by the National Institute for Medical Research and the Korean government (Kaatano *et al*., 2015). Probably, this programme resulted into a higher uptake of the preventive chemotherapy which reduced the prevalence and intensity of infection, as observed in previous studies (Hodges *et al.*, 2012; Muhumuza *et al.*, 2014). Similarly, the overall prevalence of soil-transmitted helminths infection was lower compared to reports of similar studies in either the same district (Mazigo *et al.*, 2010b) or the nearby district of Magu (Lwambo *et al.*, 1999).

The finding that hookworms are the predominant species of soil-transmitted helminths in the present study area has also been confirmed by previous studies (Lwambo *et al.*, 1999; Mazigo *et al.*, 2010b). The prevalence of other soil-transmitted helminths such as *T. trichiura, E. vermicularis* and *A. lumbricoides* has always been reported to be <1% along the Lake Victoria shores (Lwambo *et al.*, 1999;Mazigo *et al.*, 2010b). The variation in socio-demographic and socio-economic status between the communities living along the Lake Victoria shores could also in part explain the variation in prevalence and intensity of these infections. In addition, mass drug administration may have contributed in lowering the prevalence of soil-transmitted helminths.

In conclusion, the present study has revealed that the reported uptake of preventive chemotherapy in Sengerema district was high and positively associated with provision of food and information about the drug before treatment. Despite a high prevalence of uptake of preventive chemotherapy, the prevalence and intensity of *S. mansoni* was still very high, which could be due to rapid re-infection after treatment or discontinuation of MDA programme in the area. Integrating health education in mass drug administration campaigns will allow providing other complementary public preventive measures reduce the prevalence of these infections.

Competing interest

The authors declare that they have no competing interests.

Author's contribution

FB, DM and HDM designed the study. FB and HDM were responsible for data collection, analysis and manuscript preparation. DM interpreted the results and reviewed the manuscript. All authors read and approved the final manuscript.

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