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ORIGINAL ARTICLE

Prevalence of Schistosomes and Soil-Transmitted Helminths among Schoolchildren in Lake Victoria Basin, Tanzania

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Abstract: The objectives of this study was to conduct a survey on schistosomiasis and soil-transmitted helminth (STH) infections in order to come up with feasible control strategies in Lake Victoria basin, Tanzania. Depending on the size of the school, 150-200 schoolchildren were recruited for the study. Duplicate Kato-Katz stool smears were prepared from each child and microscopically examined for *Schistosoma mansoni* and STHs. Urine specimens were examined for *Schistosoma haematobium* eggs using the filtration technique. After the survey, mass drug administration was done using praziquantel and albendazole for schistosomiasis and STHs infections, respectively. A total of 5,952 schoolchildren from 36 schools were recruited for the study and had their stool and urine specimens examined. Out of 5,952 schoolchildren, 898 (15.1%) were positive for *S. mansoni*, 754 (12.6%) for hookworms, 188 (3.2%) for *Ascaris lumblicoides*, and 5 (0.008%) for *Trichuris trichiura*. Out of 5,826 schoolchildren who provided urine samples, 519 (8.9%) were positive for *S. haematobium* eggs. The results revealed that intestinal schistosomiasis, urogenital schistosomiasis, and STH infections are highly prevalent throughought the lake basin. The high prevalence of intestinal and urogenital schistosomisiasis in the study area was a function of the distance from Lake Victoria, the former being more prevalent at localities close to the lake, whilst the latter is more so away from it. Control of schistosomiasis and STHs in the study area requires an integrated strategy that involves provision of health education to communities, regular treatments, and provision of adequate safe water supply and sanitation facilities.

Key words: *Schistosoma haematobium*, *Schistosoma mansoni*, soil-transmitted helminth (STH), schoolchildren, Lake Victoria basin, Tanzania

INTRODUCTION

World Health Organization (WHO) estimated that over 237 million people required treatment for schistosomiasis in 2010 [1] with estimates of up to an additional 779 million at risk globally [2]. Schistosomiasis is endemic in 76 countries worldwide and besides malaria is the second important parasitic disease for public health [3,4]. Of the 662 million people infected worldwide, 85% are from Africa [5]. In Tanzania, schistosomiasis is highly endemic, and its prevalence varies from one region to another, with a prevalence of up to 80% in highly endemic areas [6]. Intestinal schistosomiasis is caused by *Schistosoma mansoni,* and infections are acquired by contact with freshwater containing parasite larvae. The disease is hyper-endemic in the Great Lake regions of East Africa, owing to the favorable habitat for snails of the *Biomphalaria* genus, which are the intermediate host [7]. Recent studies around Lake Victoria indicated that the prevalence in schoolchildren vary widely [8-12]. In endemic areas, initial infection is acquired at a young age. Verani et al. [13] found that 14% of 1-year-old children along the Kenyan shores of Lake Victoria were *S. mansoni* positive, whereas Odogwu et al. [14] found a prevalence of 47.4% in children <3 years of age around Lake Victoria in Uganda. The prevalence in school-aged children in

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these areas could be as high as 86-90% [15].

In children, schistosomiasis normally presents with generalized, non-specific signs and symptoms, making it difficult to identify disease-specific morbidity indicators and challenging to develop tools for assessing those indicators. Over time, morbidity may progress from subtle manifestations such as anemia, to severe, debilitating, and irreversible conditions such as growth stunting, impaired cognitive development, increased susceptibility to co-infection, decreased quality of life, exercise intolerance, infertility, portal hypertension, and liver failure [16-22].

WHO estimated that more than a billion people are chronically infected with soil-transmitted helminths (STHs) [23]. *Ascaris lumbricoides*, hookworms (*Ancylostoma duodenale* and *Necator americanus*), and *Trichuris trichiura* are the most common STH species with global prevalence of about 1,000, 900-1,300, and 500 million people, respectively [24-26]. As such, STH infections are still considered to be the most prevalent infections of mankind. Nowadays, STH has been classified among the most prevalent neglected tropical diseases (NTDs) as they persist exclusively in the poorest populations [27].

Often, schistosome infections co-occur with STHs. Findings from a study done among schoolchildren in a Lake Victoria shore line ward in Tanzania showed that the prevalence of hookworms was the second to intestinal schistosomiasis [6,28]. In Kenya, the prevalence of STHs is prominently attributed to *A. lumbricoides*, hookworms, and *T. trichiura* [29,30]. Hookworm infections observed in the lake basin in both Tanzania and Kenya were similarly high, ranging from 37.0-42.5% [10,31]. Other studies in Magu District, Tanzania, reported a prevalence of ascariasis of $<1\%$ [10], and Handzel et al. [31] reported in Kenya's Nyanza Province the prevalence of 22.9% and 17.9% for *A. lumbricoides* and *T. trichuris*, respectively.

Possible factors associated with STH infections among the studied children included age (school-age), absence of toilet and piped water supply in the household, large family size (≥ 7 members), and not washing hands before eating and after defecation [32].

Although helminths can infect all members of a population, there are specific groups who are more vulnerable and at a greater risk of infection [33,34]. For schistosomes and STHs, the most vulnerable groups are preschool children, school-aged children, and women of child-bearing age, including adolescent girls although much of the morbidity associated with infection can be reversed with the use of effective anthelmintic drug treatments [35,36].

Preschool children and school-aged children including adolescents tend to harbor the greatest numbers of intestinal worms and schistosomes and as a result experience growth stunting and diminished physical fitness as well as impaired memory and cognition [37]. These adverse health consequences combine to impair childhood educational performance, reduce school attendance [37], with hookworms being well-known causes of anemia because of intestinal blood loss [38].

Chemotherapy with praziquantel (PZQ) is currently the mainstay of control, which is available at a low cost [39,40]. Moreover, due to their geographical overlap between schistosomes and STH infections, they could be simultaneously treated with 2 drugs, albendazole and praziquantel [41]. As such, the successful STH control programmes have enormous benefits of improved nutritional and health status of the children, higher educational attainment, labor force participation, productivity, and income among the most vulnerable populations [42-44]. An added externality is the impact that NTDs have on HIV/AIDS, tuberculosis, and malaria. Several recent papers highlight the immunosuppressive features of helminths (especially the STHs, schistosomes, and filariae) and their possible impact on promoting susceptibility to the big 3 diseases [45,46]. New data suggest that control of NTDs could become a powerful tool for combating HIV/AIDS, tuberculosis, and malaria [47]. This paper presents data using a rapid assessment methodology to examine the prevalence of schistosomiasis and STH infections in schools around the Tanzania perimeter of Lake Victoria.

MATERIALS AND METHODS

Study area and population

The study area is located on the northwest of Tanzania around Lake Victoria (Fig. 1). It stretches from the southwest of the lake through south to the eastern side. The area is comprised of Kagera, Mwanza, Mara on the lake shore, and Shinyanga about 60 km away from the lake. The study area is bordered by Uganda and Rwanda in the north and west, respectively. It is also bordered by Tabora and Manyara regions in the south and east, respectively. The main ethinic groups are; Wahaya and Wasubi in Kagera region, Wasukuma, Wazinza, and Wasumbwa in Mwanza region, Wajita, Wakurya, and Waluo in Mara region, and again Wasukuma and Wasumbwa in Shinyanga region. The major occupations of these people are peasant farming, pasto-

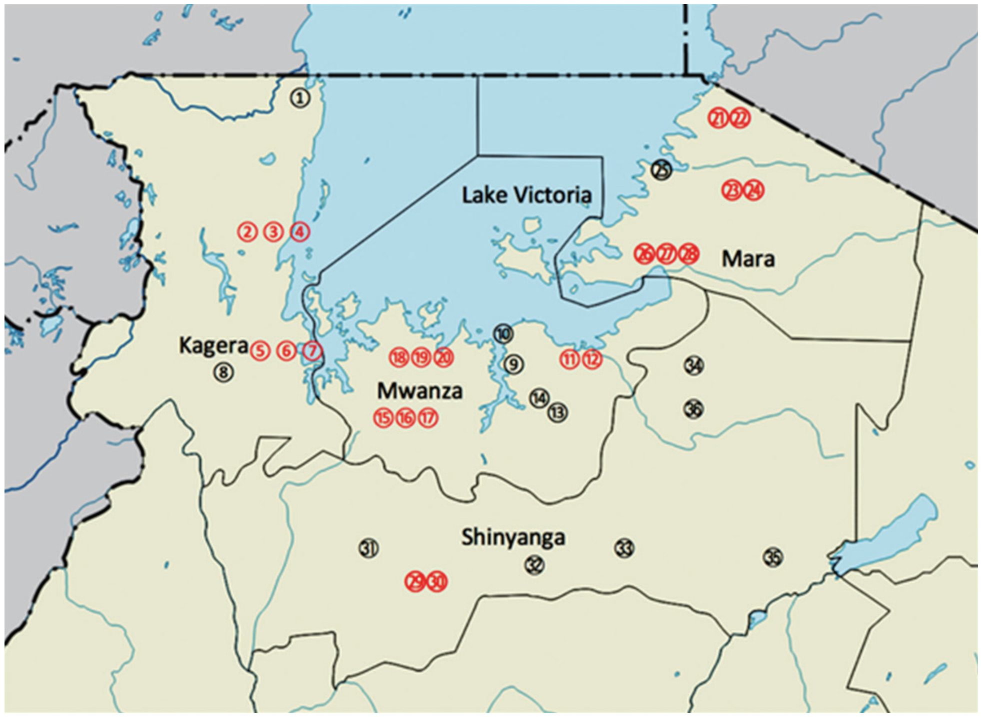

Fig. 1. Map of the study areas. Localities in Kagera region (1. Bunena, 2. Kiziramuyaga, 3. Kyenshama, 4. Nyairigamba, 5. Buzirayombo, 6. Bwanga, 7. Bwina, and 8. Runazi), Mwanza region (9. Tumaini, 10. Mazoezi, 11. Lumeji, 12. Nyamikoma, 13. Mwaging'hi, 14. Kigongo, 15. Bugogo, 16. Chibingo, 17. Kasamwa, 18. Nyakalilo, 19. Bungonya, and 20. Busisi), Mara region (21. Gamasara, 22. Ochuna, 23. Marasibora, 24. Minigo, 25. Mwisenge, 26. Guta "A", 27. Nyamitwebili, and 28. Bulamba), and Shinyanga region (29. Mseki, 30. Bukomela, 31. Masumbwe, 32. Luhumbo, 33. Songwa, 34. Shishiyu, 35. Ngugunu, and 36. Sapiwi).

ralism, and fishing. Much of the activities have a bearing to schistosomiasis and STH infections as they performed without protective gear in the area where the level of sanitation and hygiene is as low as in any poor resource settings.

Specimen collection and examinations

Collection of stool and urine specimens was done at the selected schools. Each child was given 1 stool container and 1 urine container on the first day and asked to bring the urine and stool specimens. The stool samples collected were processed to make duplicate Kato-Katz thick smears [48]. The smears were examined for hookworms and other helminth eggs or larvae within 1 hr after preparation in order to capture hookworm eggs before they hatch. Examination for *S. mansoni* eggs was done a few minutes later. The egg counts on each of the 2 slides were added together and divided by 2 to get the mean number of egg counts for the 2 slides.

Urine samples were collected after 10.00 a.m. to diagnose *S. haematobium* based on detection of eggs using the filtration technique [49]. Urine samples were mixed thoroughly and 10 ml were drawn using a syringe and passed through the membrane where eggs were logged. Examination was done on site where detected eggs were counted and expressed as the number of eggs per 10 ml of urine.

Data management and analysis

Data entry was done using Dbase IV (Borland International, Scotts Valley, California, USA), and a double entry system was used for quality control. Data were transferred to STATA version 8 software (Statacorp 2000, College Station, Texas, USA) for analysis. Analysis was done by generation of some frequency tables, cross tabulations, and calculation of the prevalence.

Ethical considerations

The ethical and scientific clearance was obtained from the Medical Research Coordinating Committee of the National Institute for Medical Research before the implementation of the study. The study team visited villages and schools where community leaders and teachers were respectively met and the objectives, procedure, and potential harm and benefits of the study were explained to them. The leaders in turn convened meetings of the community members, and the same was explained to them before the consent to participate in the study was sought. A similar procedure was followed at schools.

Schoolchildren were told that participation to the study would be voluntary and free. Any participant would be free to withdraw from the study at any time of the study period when he or she felt to do so. The decision to refuse or withdraw from the study would have no negative effect on the benefits provided during and after the study.

All subjects who would be found infected with schistosomes and intestinal helminths were treated following standard treatment guidelines using praziquantel and albendazole tablets. Participants were informed that information will be confidentially kept using code numbers instead of names of participants.

RESULTS

A total of 5,848 schoolchildren from 36 selected schools in the 4 regions of the Lake Victoria basin in Tanzania were recruited for the study (Table 1). The same numbers of girls and boys aged between 7 and 16 years from class 1 to 7 were selected for the study. Intestinal schistosomiasis caused by *S. mansoni* was prevalent in 3 regions of Kagera, Mwanza, and Mara. The highest prevalence of *S. mansoni* (24.8%) was recorded in Mwanza region. Hookworms were the only helminths prevalent in all 4 regions. The prevalence of hookworms ranged from 6.7% in Shinyanga to 32.3% in Kagera. Ascariasis and trichuriasis were prevalent in Kagera and Mara regions only. A remarkably high prevalence of ascariasis (17.4%) was found in Kagera region.

Urogenital schistosomiasis caused by *S. haematobium* was found in children from 3 regions of Mwanza, Mara, and Shinyanga but not in Kagera. Among the 3 regions, the highest prevalence (16.7%) was recorded in Shinyanga region. The mean prevalence of both schistosomiasis and STHs in all regions ranged from low to moderate ones (Table 1).

In Kagera region, all the common intestinal helminths, namely *S. mansoni*, *A. lumbricoides*, *T. trichiura*, and hookworm infections were prevalent (Table 2). Bwina Primary School in Chato District recorded an extremely high prevalence of intestinal schistosomiasis of 86.5% followed by Bunena in Bukoba

Table 1. Regional mean prevalence of schistosomes and soil-transmitted helminths among schoolchildren in Lake Vitoria Basin, Tanzania

Region	Helminth eggs in stool					*S. haematobium*	
	No. exam.	*S. mansoni*	Hookworms	*A. lumbricoides*	*T. trichiura*	No. exam.	No. egg posit. in urine (%)
		No. posit. (%)	No. posit. (%)	No. posit. (%)	No. posit. (%)		
Kagera	1,012	171 (16.9)	327 (32.3)	176 (17.4)	15 (1.5)	1,012	0 (0.0)
Mwanza	2,146	532 (24.8)	331 (15.4)	0 (0.0)	0 (0.0)	2,042	193 (9.5)
Mara	1,203	160 (13.3)	96 (8.0)	12 (1.0)	3 (0.2)	1,203	58 (4.8)
Shinyanga	1,465	0 (0.0)	98 (6.7)	0 (0.0)	0 (0.0)	1,591	265 (16.7)
Total	5,826	863 (14.8)	852 (14.6)	188 (3.2)	18 (0.3)	5,848	516 (8.8)

Table 2. Prevalence of schistosomes and soil-transmitted helminths among schoolchildren in Kagera region

District	Locality	Helminth eggs in stool				
		No. exam.	*S. mansoni*	Hookworms	*A. lumbricoides*	*T. trichiura*
			No. posit. (%)	No. posit. (%)	No. posit. (%)	No. posit. (%)
Bukoba urban	Bunena	125	21 (16.8)	2 (1.6)	32 (25.6)	4 (3.2)
Muleba	Kiziramuyaga	126	0 (0.0)	75 (59.5)	21 (16.7)	9 (7.1)
Muleba	Kyenshama	125	0 (0.0)	25 (20.0)	32 (25.6)	0 (0.0)
Muleba	Nyairigamba	140	1 (0.7)	14 (10.0)	24 (17.1)	1 (0.7)
Chato	Buzirayombo	120	7 (5.8)	44 (36.7)	40 (33.0)	0 (0.0)
Chato	Bwanga	95	4 (4.2)	36 (37.9)	27 (28.4)	0 (0.0)
Chato	Bwina	155	134 (86.5)	41 (26.5)	0 (0.0)	0 (0.0)
Biharamulo	Runazi	126	4 (3.2)	90 (71.4)	0 (0.0)	2 (1.6)
Total		1,012	171 (16.9)	327 (32.3)	176 (17.4)	15 (1.5)

Urban District with a prevalence of 16.8%, and other schools had a prevalence of less than 10%. No *S. haematobium* positive cases were recorded in Kagera region. Hookworms were prevalent in the Kagera region. The highest prevalence was 71.4% at Runazi School followed by Kiziramuyaga 59.5% and Bwanga 37.9% (Table 2). The prevalence of ascariasis was the highest at Buzirayombo 33.3%, followed by Bwanga 28.4%, Bunena 25.6%, and Kyenshama 25.6% (Table 2). The prevalence of trichuriasis in the region was relatively low with a mean of 1.5% where Kiziramuyaga had the highest prevalence of 7.1%.

In Mwanza region, 3 helminth species detected included *S. mansoni*, *S. haematobium*, and hookworms (Table 3). The highest prevalence of *S. mansoni* infection was recorded at Nyamikoma Primary School that registered 79.2%, followed by Bungonya 63.1% and Nyakaliro 63.0% (Table 3). Bungonya Primary School had the highest prevalence of hookworms of 36.9% followed by Mwagingh'i 34.0% and Nyamikoma 21.3%. The highest prevalence (32.2%) of urogenital schistosomiasis was at Bugogo Primary School (32.3%), and Mwaging'hi and Kigongo were the second with a prevalence of both 28.0%. Lumeji was the fourth with 21.3% prevalence while the rest of schools had prevalence less than 10% (Table 3).

The distribution of schistosomiasis and STHs in Mara region was low relative to other regions (Table 4). *S. mansoni* was highly prevalent at Mwisenge 36.1%, Nyamitwebili 30.2%, Gamasara 15.9%, and Minigo 11.7%. Other schools had prevalence lower than 10% (Table 4). Urinary schistosomiasis was found in 3 schools only. The prevalence was the highest (27.2%) at

Table 3. Prevalence of helminths in stool and urine samples among schoolchildren in Mwanza region

District	Name of School	Helminth eggs in stool			*S. haematobium* eggs in urine	
		No. exam.	*S. mansoni* No. posit. (%)	Hookworms No. posit. (%)	No. exam.	No. posit. (%)
Ilemela	Tumaini	204	72 (35.3)	19 (9.3)	2	0 (0.0)
Nyamagana	Mazoezi	175	19 (10.9)	13 (7.5)	65	0 (0.0)
Magu	Lumeji	95	0 (0.0)	2 (2.1)	80	17 (21.3)
Magu	Nyamikoma	178	141 (79.2)	38 (21.3)	161	8 (5.0)
Kwimba	Mwaging'hi	235	1 (0.4)	80 (34.0)	161	45 (28.0)
Misungwi	Kigongo	235	36 (15.3)	1 (0.4)	161	45 (28.0)
Geita	Bugogo	180	8 (4.4)	19 (10.6)	192	62 (32.3)
Geita	Chibingo	195	0 (0.0)	59 (30.3)	192	4 (2.1)
Geita	Kasamwa	129	0 (0.0)	19 (14.7)	151	1 (0.7)
Sengerema	Nyakalilo	181	114 (63.0)	13 (7.2)	182	2 (1.1)
Sengerema	Bungonya	160	101 (63.1)	59 (36.9)	186	6 (3.2)
Sengerema	Busisi	179	40 (22.3)	9 (5.0)	177	3 (1.7)
Total		2,146	577 (26.9)	331 (15.4)	2,042	193 (9.5)

Table 4. Prevalence of schistosomes and soil-transmitted helminths among schoolchildren in Mara region

District	Locality	Helminth eggs in stool					*S. haematobium* eggs in urine
		No. exam.	*S. mansoni* No. posit. (%)	Hookworms No. posit. (%)	*A. lumbricoides* No. posit. (%)	*T. trichiura* No. posit. (%)	No. posit. (%)
Tarime	Gamasara	157	25 (15.9)	20 (12.7)	3 (1.9)	0 (0.0)	0 (0.0)
Tarime	Ochuna	155	0 (0.0)	10 (6.5)	0 (0.0)	0 (0.0)	0 (0.0)
Rorya	Marasibora	147	1 (0.7)	9 (6.1)	0 (0.0)	0 (0.0)	0 (0.0)
Rorya	Minigo	145	17 (11.7)	28 (19.3)	1 (0.7)	1 (0.7)	17 (11.7)
Musoma Urban	Mwisenge	169	61 (36.1)	4 (2.4)	7 (4.1)	1 (0.6)	0 (0.0)
Bunda	Guta "A"	125	2 (1.6)	3 (2.4)	0 (0.0)	0 (0.0)	34 (27.2)
Bunda	Nyamitwebili	159	48 (30.2)	18 (11.3)	1 (0.6)	0 (0.0)	0 (0.0)
Bunda	Bulamba	146	6 (4.1)	4 (2.7)	0 (0.0)	1 (0.7)	4 (2.7)
Total		1,203	160 (13.3)	96 (8.0)	12 (1.0)	3 (0.2)	58 (4.8)

Table 5. Prevalence of schistosomes and soil-transmitted helminths among schoolchildren in Shinyanga region

District	Locality	Helminth eggs in stool		*S. haematobium* eggs in urine	
		No. exam.	Hookworm egg posit. (%)	No. exam.	No. posit. (%)
Kahama	Mseki	197	14 (7.1)	226	25 (11.1)
Kahama	Bukomela	170	29 (17.1)	186	42 (22.6)
Bukombe	Masumbwe	194	25 (12.9)	200	11 (5.5)
Shinyanga Rura	Luhumbo	188	12 (6.4)	198	60 (30.3)
Kishapu	Songwa	198	0 (0.0)	222	55 (24.8)
Maswa	Shishiyu	206	12 (5.8)	214	40 (18.7)
Meatu	Ngugunu	178	4 (2.2)	186	14 (7.5)
Bariadi	Sapiwi	134	2 (1.5)	159	18 (11.3)
Total		1,465	98 (6.7)	1,591	265 (16.7)

Guta “A” School followed by Minigo 11.7% and Bulamba 2.7%. The prevalence of hookworms in Mara region ranged from 2.4% at Mwisenge to 19.3% at Minigo Primary School. The prevalence of trichuriasis was the lowest of all the helminths in region.

In Shinyanga region, urogenital schistosomiasis was prevalent in all schools studied (Table 5). The highest prevalence (30.3%) was noted at Luhumbo School in Shinyanga Rural District seconded by 24.8% at Songwa Primary School in Kishapu District. Intestinal schistosomiasis was not noted in the whole study areas, whereas the hookworm prevalence was low; ranging from 0% at Songwa School to 17.1% at Bukomela School. No ascariasis nor trichuriasis cases were noted at any of the schools in Shinyanga region.

DISCUSSION

The results showed that generally the prevalence of *S. mansoni*, *S. haematobium*, and STHs are considerably high in the study areas. Similar observations were reported from earlier studies in Magu and Sengerema in the same areas [10,50]. However, the prevalence of *S. mansoni* in Kagera region is very low with the exception of a few pockets in Chato District which is currently in Geita region. This could be attributed to the fact that lake shores in Kagera region are open instead of bays when wind blows make the waves splash the shores making the place an unconduncive habitat for snail intermediate hosts. Moreover, some of the shores in Kagera region are formed by escarpments thus deep and less habitable by the snails. The situation is quite different from shores in Chato District which is a bay thus most of its shores are not susceptible to strong winds. The distribution of *S. haematobium* and *S. mansoni* along Lake Victoria is largely related to the distribution of the intermediate hosts [51]. Along the shore of the lake, members of the genus *Biomphalaria*, the intermediate host for *S. mansoni*, are common [52,53] with populations living along the lake shores and islands being highly affected by *S. mansoni* as the risk of infection increases [53,54].

The shores in Chato Districts are shallow; thus very conduncive for *Biomphararia* snails. This is why the district recorded high prevalence of intestinal schistosomiasis. Apart from the fact that schistosomiasis is focal, the noted high prevalence of the disease in this district could be attributed to the presence of bays that experience less speedy winds and strong waves to the shores making the place unconduncive habitat for snails.

The highest prevalence of *S. mansoni* at Bwina Primary School in Kagera region could be attributed to the location of the study site. Bwina ward is a thin peninsular with an average width of less than 2 km. As such, most of the area is surrounded by Lake Victoria water that is inhabited by *Biomphararia* species. Bwanga and Kiziramuyaga localities are close to the lake area that has small bays that are conduncive areas for the snail hosts. The absence of urogenital schistosomiasis in Kagera region could be due to the absence of ponds and streams, and the fact that no paddy cultivation is practiced in this area.

The prevalence of STH infections in Kagera region was relatively higher than that in other regions. This could be due to the difference in natural vegetations and gardens as a result of rain variations. Kagera is sunny and warm most of the year with cool evenings and rains occuring almost every morning from March through May [55]. STHs are highly affected by surface temperature [56], altitude, soil type, and rainfall [57]. This has an implication of the region having the best breeding ground of STHs as well as more people consuming semi-cooked vegetables that may carry helminth eggs.

In Mwanza region, the distribution of *S. mansoni* was similar to that of Mara with more happenings close to the lake and *S. haematobium* on the hinterland. The high prevalence of intestinal and urogenital schistosomisiasis in the study area was a function of the distance from Lake Victoria, the former being more prevalent at localities close to the lake, whilst the latter is more so away from it [52-54]. Moreover, in areas where the prevalence of *S. haematobium* was high, there was a significant prevalence of hookworms. The findings are in line with other studies in Magu District in Mwanza region [10-12]. The spatial distribution of *S. haematobium* is in accordance to the presence of ponds and streams as well as the wetness and warmth of the soil that are prerequisites for proliferation of the 2 helminths.

We could not easily establish why there were no *Ascaris* or *Trichuris* infections in Mwanza and Shinyanga regions that are situated in the middle of the study area. Similar findings were reported by Mazigo on 1 ward in the region [50]. Difference in soil structure and texture as well as climate among the regions could be the reasons for the difference. Kagera region on the west bordering southern Uganda and Mara region on the west which borders western Kenya have similar prevalence of the STHs as compared to Mwanza and Shinyanga regions [50,54]. The prevalence of hookworm infections, 34% at Mwaging'hi in Kwimba District, and 21.7% at nearby Nyamikoma location in Magu District, was similar to an ealier report in the same area [10]. Despite the fact that Mara region is closer to the western province in Kenya with similar types of STH infections, they differed in prevalence. This study recoded a mean regional prevalence ranging from 1% to 8% whereas studies in Kenya's Nyanza Province reported the prevalence of 22.9% and 17.9% for *A. lumbricoides* and *T. trichuris,* respectively [10,50].

In Mara region, the high prevalence of intestinal schistosomiasis at Mwisenge and Nyamitwebili schools were associated with their being very close to the lake shore. The study team could see children sent to the lake to fetch water. The high prevalence of urogenital shistosomiasis at Guta "A" and Minigo could be ascribed to paddy fields, that are good habitats for the snail intermediate host of *S. haematobium*, that were enormous in the sourounding areas. In Mara region, the distribution of *S. mansoni* was similar to that of Mwanza. Moreover, in areas where schistosomiasis was high, there was a significant prevalence of hookworms. This association was reported elsewhere; these findings are in line with that from Magu District in Mwanza region and in western Kenya [10,57,58]. As expected, the prevalence of intestinal schistosomiasis was extremely low in Shinyanga region that is more than 150 km away from the lake but had the highest prevalence of urogenital schistosomiasis.

The results showed that schistosomisasis and 3 STHs infections are co-endemic in Lake Victoria basin in Tanzania with a high probability of polyparasitism in the study participants. The prevalence of *S. mansoni*, *S. haematobium*, and STHs ranged from low to moderate in most parts of the study area. Intestinal schistosomiasis was prevalent along the Lake Victoria shores and decreased with distance from it. Conversely, the prevalence of urogenital schistosomiasis increased with distance from the Lake.

From the study findings, we recommend the followings to control schistosomiasis in the study area. First, there is a need for provision of health education to community members. This could be given in a participatory manner so that each member gets engaged in the learning process especially through peer educators. Second, study teams need to conduct regular research in order to control incidence and reinfection rates in the area by carrying out regular treatment exercises. Third, community-based provision of adequate safe water supply and sanitation facilities are imperative. Water supply could be done through construction/drilling of wells at each sub-village, institutions, and health facility.

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CONFLICT OF INTEREST

There is no conflict of interest declared by any of the authors.

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