Childhood Activities and Schistosomiasis Infection in the Kassena-Nankana District of Northern Ghana

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Abstract

Schistosomiasis is a common cause of morbidity especially among rural children in less developed countries. The extent and distribution of schistosomiasis infection among school-age children was assessed and the association between some childhood activities and prevalence of infection was determined in northern Ghana. A cross-sectional study was conducted during which stool and urine samples were collected from children 6-15 years. Samples were analysed using the Kato-Katz technique and the 10 ml urine filtration methods respectively. Data on water contact activities were also collected. The level of infection was compared in relation to location and water contact activities. A total of 1,764 children participated in the study. Prevalence of *Schistosoma haematobium* infection was 18.9%. The highest level of infection (33.1%) was found among children resident in the southern part of the district, the lowest among those in the eastern (3.6%) and northern (3.8%) parts. *S. mansoni* infection was 10.9%. The highest level of *S. mansoni* infection (54.2%) was found among children resident in the central part of the district. The overall prevalence of infection (*S. haematobium*+*S. mansoni*) was moderate (27.1%). More males (32.5%) than females (20.2%) were infected (χ^2=32.8, P<0.0001). Children aged 9-12 years had the highest prevalence of infection (31.8%; 95% CI: 28.4-35.5) with the lowest among those aged 6-8 years (23.9%; 95% CI: 20.2-28.0). Swimming in the canals (χ^2=404.4, P<0.0001) and working on tomato farms (χ^2=37.7, P<0.0001) were risk factors for infection. Herding cattle appeared to have protected the children from infection (χ^2=34.8, P=0.0001). Schistosomiasis is prevalent throughout the district with children resident in the central and southern parts of the district being more at risk of infection. There is the need to put in place an integrated and effective schistosomiasis control programme.

Keywords: Schistosomiasis; Kassena-Nankana district; Tono irrigation scheme; Water contact activities; School-age children; Herding cattle; Childhood activities

Introduction

Human schistosomiasis, also known as bilharzia, is a complex of acute and chronic parasitic infections caused by mammalian blood flukes belonging to the genus *Schistosoma*. The disease is endemic in 74 countries and considered second only to malaria in terms of the socio-economic and public health importance in the tropics and sub-tropics. An estimated 200 million people are infected, of whom 120 million are symptomatic and 20 million have severe disease. Six hundred million people are at risk of infection [1].

There are two forms of the disease namely urogenital and intestinal schistosomiasis. Urogenital schistosomiasis is due to *Schistosoma haematobium* whilst the intestinal form is caused by *S. mansoni, S. japonicum, S. mekongi, S. guineensis* and *S. intercalatum* [2]. Depending on the species of parasite, schistosomiasis leads to renal and bladder damage or liver and intestinal disease and contributes to anemia, growth retardation and impaired cognitive development in children. The disease also contributes to malnutrition and disrupts school attendance.

Humans become infected when the larval forms of the parasite (cercariae) – released by freshwater snails – penetrate the skin in the course of wading, bathing, swimming, washing clothes, or performing other household chores in contaminated freshwater. *Bulinus globosus* and *B. truncatus* are the intermediate host snails of *S. haematobium* [3] in Ghana whilst *Biomphalaria pfeifferi* is responsible for the transmission of *S. mansoni* [4,5].

Schistosoma infection is usually acquired in childhood as children tend to spend time swimming or bathing in snail infested freshwater. Prevalence and intensity of infection increase with age, peaking in the 5 to 14 year age group [6]. In older people, there is a drastic decline in intensity of infection but not in the prevalence of the disease.

The present work was undertaken to assess the extent and distribution of schistosomiasis infection among school-age children and establish the association between some childhood activities and responsibilities including swimming, working on tomato farms, and herding cattle and the prevalence of infection in the Kassena-Nankana district of northern Ghana. The current paper, to the best of our knowledge is the first comprehensive parasitological report on schistosomiasis that has covered the entire district [5,7,8].

Materials and Methods

Study site and population

The study was conducted in the Kassena-Nankana District (KND) in northern Ghana. The district covers an area of about 1,674 km² of Sahelian savannah with an estimated population of 144,000 [9]. The main occupation of the inhabitants is subsistence farming of millet, groundnut, rice, vegetables and livestock. The average annual rainfall is 850 mm, almost all of which occur in the months of June-October, with the rest of the year being relatively dry [10]. Most of the people live in multi-family compounds, which form the basis of the address system used in the Navrongo Health and Demographic Surveillance System (NHDSS), and are separated from one another by agricultural land. A large reservoir (Tono dam) in the middle of the district and about 90 dug-out dams provide water throughout the year for agricultural irrigation purposes [11].

Sample size estimation

Two main assumptions were made during the sample size estimation. We expected a higher prevalence of schistosomiasis infection (about 80%) in non-enrolled school-age children than in the enrolled children (about 70%) [5] mainly in the irrigated area. At a confidence level of 95% and a power of 80%, a sample size of 412 each of enrolled and non-enrolled school-age children was deemed adequate to demonstrate any differences in prevalence among in-school and not-in-school children in the study area. We also assumed an overall prevalence of infection of 50% in the non-irrigated area. At a confidence level of 95% and power of 80%, a minimum sample of 434 was deemed adequate to detect any significant differences in infection in terms of location. To make room for non-response a sample size of 1,764 was considered adequate for any sub-analysis.

Field procedures

Stool and urine samples collection and haemoglobin measurement: Stool and urine samples were collected from children aged 6-15 years resident in the Kassena-Nankana district from March-June 2008. A simple random sampling procedure was employed in which representative sample lists of eligible participants resident in all zones of the district were generated from the NHDSS database. The eligibility criteria were: being aged 6-15 years and being resident in any of the five NHDSS designated zones in the district for at least one year. Samples were allotted proportional to the size of eligible children in the zones while making room for loss to follow-up in the generation of the random list. Participants were enrolled in a sequential manner during sample collection until the predetermined number for the particular zone was obtained. Children not in-school were traced into their homes early in the morning using compound identifiers and mother's name. In-school children were contacted at school for sample collection and questionnaire administration. Stool sample containers were distributed to the potential study participants in their homes or at school a day before sample collection for them to provide samples the next morning. Urine sample containers were however provided on the day of sample collection. Samples were collected between the hours of 10:00 and 12:00 either at school or at home. Stool and urine samples were transported in ice chests with ice packs just after collection to the laboratory at Navrongo Health Research Centre for processing and examination. Blood haemoglobin concentration levels were determined from finger prick blood samples with an automated photometer (HemoCue AB, Sweden Instruments).

Laboratory analyses

The Kato-Katz technique [12] was used for the determination of prevalence of *Schistosoma mansoni* infection. Infection was determined using optic microscopy and counting the eggs present in 41.7 mg of faeces. One aliquot of 10 ml urine sample was filtered using a 10 ml syringe and nylon monofilament and the filter placed on a single slide labeled with the identification number of the child and date of collection. The slides were examined microscopically and the eggs count expressed as number per 10 ml of urine. All samples were processed within 24 hrs of collection.

Questionnaire administration

Data on water contact activities (bathing, washing of clothes and swimming in the canals or dams; working on irrigated farms) were collected using a questionnaire. Other activities like herding of cattle were also collected from the children. The questionnaire was also used to update their school enrolment status. The children were also questioned on whether they have ever seen blood in their stool and/or urine. Their demographic data were accessed from the NHDSS database. The questionnaires were administered by trained field staffs who speak the local languages as well as English. All data forms were checked by field supervisors for completeness and thoroughness and any omissions corrected in the field before being brought to the office for batching and data entry into a computer database.

Data analyses

The overall mean and standard deviation of the intensity of infection was calculated. The intensity of infection with *S. haematobium* was classified into three groups: light (1-49), moderate (50-99) and heavy (≥ 100 eggs in 10 ml of urine). The intensity of infection with *S. mansoni* was expressed as eggs per gramme (epg) of faeces by multiplying the number of eggs in the 41.7 mg specimen by 24 [13]. The degree of intensity of *S. mansoni* was also classified into three groups: light (1-99), moderate (100-399) and heavy (400 eggs and over per gram of faeces) [13]. The prevalence of infection was tabulated against type of childhood activity, being in-school, as well as area of residence and the chi-squared test obtained. All statistical tests were two sided and an alpha level of <0.05 was considered a statistically significant result. The 95% confidence intervals were also used where appropriate.

Ethical considerations

Ethical approval was obtained from the Institutional Review Board of the Navrongo Health Research Centre of the Ghana Health Service before commencement of the study (Ethics approval No: NHRCIRB049). Written informed consent was obtained from the parents of the children before participation in the study. Assent was also obtained from those children aged 10 to 15 years. Permission was obtained from the chiefs and elders of the communities in which the study was conducted. Community meetings were organized in all the communities and the study explained to them. The District Education Office was also contacted and permission sought. Children who were found to be infected were referred to the nearest health facility for treatment. They were treatment based on the recommended drug regimen of a single dose of praziquantel (40 mg/kg body weight).

Results

Socio-demographic, haematological and parasitological measurements

A total of 1,764 school-age children (6-15 years) participated in the survey: 987 males (56.0%) and 777 females (44.0%). Overall, most of the children (74.4%) were in-school; however, in the southern and central parts of the district only 45-53% were in-school. The mean age was 10.8 years (SD: 2.9; range: 6-15) and the mean haemoglobin concentration was 11.3 g / dl (SD: 1.6; range 5.6- 16.0). Hb and age distribution were similar for children resident in all parts of the district, and no association was found between the intensity of infection and Hb concentrations (Table 1).

The prevalence of *Schistosoma haematobium* infection was 18.9% (333 / 1764); with a geometric mean egg density of 7.1 eggs per 10 ml of urine. The intensity of infection was generally low throughout the district. The highest level of infection (33.1%) was found among children resident in the southern part of the district with the lowest among those resident in the eastern (3.6%) and northern (3.8%) parts of the district. Infection with *S. mansoni* was 10.9% (193/1764) with a geometric mean egg density of 69.6 eggs per gram (epg) of faeces. The highest level of *S. mansoni* infection (54.2%) was found among

Indicator	Area of residence in the Kassena-Nankana district					
	East	West	North	South	Central	Total
	n=361	n=727	n=53	n=505	n=118	N=1764
Males [%]	161 [44.6]	401 55.2]	30 [56.6]	310 [61.4]	85 [72.0]	987[56.0]
Females [%]	200 [55.4]	326 [44.8]	23 [43.4]	195 [38.6]	33 [28.0]	777[44.0]
In-school [%]	356 [98.6]	613 [84.3]	51 [96.2]	229 [45.3]	63 [53.4]	1312[74.4]
Not-in-school [%]	5 [1.4]	114 [15.7]	2 [3.8]	276 [54.7]	55 [46.6]	452 [25.6]
Mean age in years [SD]	11.0 [3.0]	11.1 [2.8]	11.2 [2.3]	10.1 [2.8]	10.6 [2.6]	10.8[2.9]
Mean Hb in g/dl [SD]	11.3 [1.5]	11.4 [.7]	11.1 [1.2]	11.4 [1.6]	11.2 [1.7]	11.3[1.6]
Prevalence of Schistosoma haematobium (%) [95% CI]	3.6 (13/363) [1.9-6.1]	18.2 (132/727) [15.4-21.2]	3.8 (2/53) [0.5-13.0]	33.1 (167/505) [29.0-37.4]	16.1 (19/118) [10.0-24.0]	18.9(333/1764) [17.1-20.8]
Prevalence of Schistosoma mansoni (%)	0.8 (3/363)	8.3 (56/727)	0 (0/53)	13.9 (70/505)	54.2 (64/118)	10.9(193/1764)
[95% CI]	[0.17-2.4]	[6.4-10.7]	[0-6.6]	[11.0-17.2]	[44.8-63.4]	[9.5-12.5]
Geometric mean egg density of S. haematobium	2.2	7	2.6	8.5	4.1	7.1
Geometric mean egg density of S. mansoni	33.6	52.8	0	48	127.7	69.6

Table 1: Characteristics of school-age children (6-15 years) who participated in the study.

Background characteristics		S. haematobium infection	S. mansoni infection	S. haematobium + S. mansoni infection	χ^2 Yates corrected P-value
		No infected (% infected)	No infected (% infected)	No infected (% infected)	
Total population	1764	333 18.9	193 10.9	478 27.1	
Male	987	230 23.3	131 13.3	321 32.5	32.8
Female	777	103 13.3	62 8	157 20.2	<0.0001
In-school	1312	161 12.3	129 9.8	269 20.5	111.4
Not-in- school	452	172 38.1	64 14.2	209 46.2	<0.0001

Table 2: Prevalence of schistosomiasis infection among school-age children in an irrigation community in rural northern Ghana.
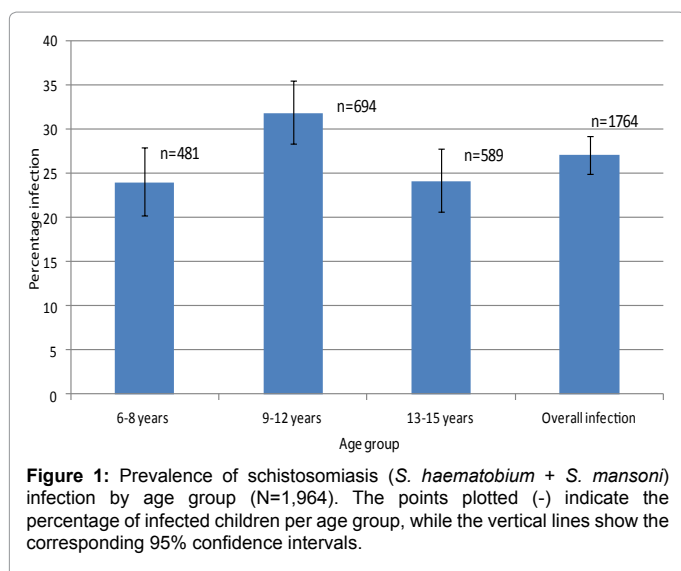

Figure 1: Prevalence of schistosomiasis (S. haematobium + S. mansoni) infection by age group (N=1,964). The points plotted (-) indicate the percentage of infected children per age group, while the vertical lines show the corresponding 95% confidence intervals.

but the geometric mean density of eggs were higher for females than males [S. haematobium: males=6.8, females 8.0 eggs per 10 ml of urine; S. mansoni: males=60, females=93.6 eggs per gram (epg) of faeces].

Children aged 9-12 years had the highest prevalence of infection (31.8%; 95% CI: 28.4-35.5) with the lowest level of infection among those aged 6-8 years (23.9%; 95% CI: 20.2-28.0). The difference in the levels of infection among children in the age group of 9-12 years and the other two age groups was statistically significant (prevalence of infection for age group 13-15 years=24.1%, 95% CI: 20.7-27.8) (Figure 1).

Childhood activities and the associated risk of schistosomiasis infection

Some childhood activities like swimming and washing of clothes in the irrigation canals or dams and assisting on tomato farms were major risk factors that exposed the children to schistosomiasis infection. A high percentage (59.5%) of the children indicated that they swim frequently in the canals and dams with as many as 70.5% (695/987) of the males swimming frequently. Significantly more children who swim frequently than those who do not were infected (χ^2=404.4, P<0.0001). Children who assisted on tomato farms were also more likely to be infected than those who did not (χ^2=37.7, P<0.0001). Other activities such as taking care of cattle in the fields appeared to have protected the children from infection (χ^2=34.8, P=0.0001). Caring for or herding of cattle was a major childhood activity undertaken by male children (67.9%; 670/987) with 45.4% (353/777) of female children also engaged

children resident in the central part of the district where the intensity of infection was also moderate.

The overall prevalence of infection (S. haematobium + S. mansoni) was moderate (27.1%) (Table 2). More males (32.5%, 321/987) than females (20.2%, 157/777) were found to be infected (χ^2=32.8, P<0.0001);

in this activity (Table 3).

Area of residence, childhood responsibilities/activities and schistosomiasis infection

Area of residence in the district was found to be very important in terms of exposure to schistosomiasis infection as shown in Figure 2. Children resident in the central part of the district recorded
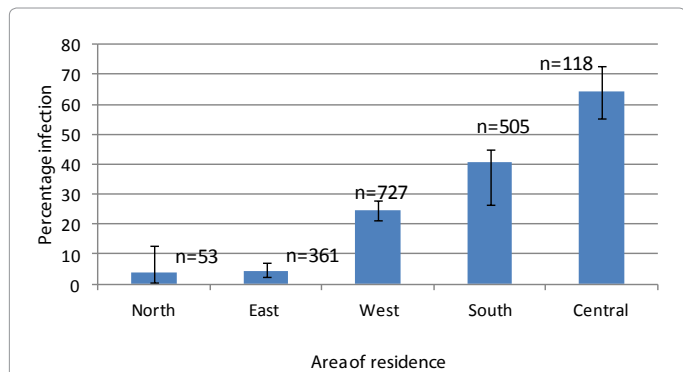

Figure 2: Prevalence of schistosomiasis (*S. haematobium* + *S. mansoni*) infection by area of residence (N=1,964). The points plotted (-) indicate the percentage of infected children per area of residence, while the vertical lines show the corresponding 95% confidence intervals.

the highest level of infection of 64.4% (76/118), followed by those resident in the southern part (40.6%, 205/505). The northern part had the lowest prevalence of infection in the district (3.8%, 2/53). The level of infection among children resident in the central part was significantly higher than the levels among those resident in the other four parts of the district; similarly, the level of infection was much higher among children resident in the western part (24.6%) compared to those living in the eastern (4.4%) and northern parts (3.8%).

The level of participation in the identified childhood activities/responsibilities was also found to vary depending on which part of the district the child resides. Children resident in the central part of the district were found to engage more in bathing and washing in the canals and dams as well as working on rice and tomato farms than their counterparts residing in the other parts of the district. Working on tomato farms for example exposed the children to schistosomiasis infection (χ^2=37.7, P<0.0001). In the case of children resident in the western part of the district, engaging in activities like bathing and washing in the canals and dams as well as working on rice and tomato farms exposed them to schistosomiasis infection (*P*<0.0001) (Table 4).

	Total number of children N=1764				
Activity	No. of males who undertake activity	No. of females who undertake activity	Total No. of children who undertake activity	Total No. infected	*P-value*
	(%)	(%)	(%)	(%)	
Bath in the canals/dams	695	355	1050	356	*<0.0001*
	-70.5	-45.9	-59.5	-33.9	
Washing clothes	493	330	823	318	*<0.0001*
	-50	-42.5	-46.7	-38.6	
Washing cooking utensils	55	243	298	92	*0.12*
	-5.6	-31.3	-16.9	-30.9	
Working on rice farms	676	513	1189	327	*0.62*
	-68.5	-66.1	-67.4	-27.5	
Working on tomato farms	416	283	699	246	*<0.0001*
	-42.2	-36.4	-39.6	-35.2	
Taking care of cattle in the field	670	353	1023	223	*0.0001**
	-67.9	-45.4	-59	-21.8	

*More infections were found among children who do not take care of cattle in the field

Table 3: Various childhood activitie`s and the associated risks of schistosomiasis infection

Activity/responsibility		Area of residence				
		East N=361	West N=727	North N=53	South N=505	Central N=118
		% infection *P-value*	% infection *P-value*	% infection *P-value*	% infection *P-value*	% infection *P-value*
Bath in canals/dam	Yes	5.5 (10/181)	33.5 (126/376)	0 (0/34)	43.1 (150/348)	63.1 (70/111)
	No	3.4 (6/178) *0.44*	15.2 (53/349) *<0.001*	11.1(2/18) *0.12*	35.0 (55/157) *0.09*	92.1 (6/7) *0.42*
Wash clothes in canal/dam	Yes	5.2 (6/116)	36.6 (107/292)	5.3 (1/19)	46.6 (138/296)	66.0 (66/100)
	No	4.1 (10/245) *0.6*	16.6 (72/435) *<0.001*	2.9 (1/34) *1.0*	32.1 (67/209) *0.001*	55.6 (10/18) *0.43*
Wash cooking utensils in canals/dam	Yes	7.4 (4/54)	29.5 (31/105)	0 (0/14)	39.0 (37/95)	66.7 (20/30)
	No	3.9(12/307) *0.28*	23.8 (148/622) *0.22*	5.1 (2/139) *1.0*	41.0 (168/410) *0.73*	63.6 (56/88) *0.83*
Work on rice farm	Yes	4.3 (10/233)	20.7 (102/492)	3.3 (1/31)	43.6 (144/330)	68.0 (70/103)
	No	4.7 (6/127) *1.0*	32.8 (77/235) *<0.001*	4.6 (1/22) *1.0*	34.9 (16/175) *0.06*	12.7 (6/15) *0.04*
Work on tomato farm	Yes	3.9 (5/128)	34.2 (80/234)	3.7 (1/27)	42.9 (91/212)	70.4 (69/98)
	No	4.7(11/233) *0.80*	20.1 (99/493) *<0.001*	3.9 (1/26) *1.0*	38.9 (114/293) *0.41*	35.0 (7/20) *0.004*
Herding cattle	Yes	4.4 (13/293)	17.4 (78/449)	5.4 (2/37)	50.8 (94/185)	61.0 (36/59)
	No	4.6 (3/65) *1.0*	36.3 (101/278) *<0.001*	0 (0/16) *1.0*	34.7 (111/320) *<0.001*	67.8 (40/59) *0.56*
In-school	Yes	4.5 (16/356)	20.1 (123/613)	2.0 (1/51)	34.1 (78/229)	81.0 (51/63)
	No	0.0 (0/5) *1.0*	49.1 (56/114) *<0.001*	50.0 (1/2) *0.07*	46.0 (127/276) *<0.001*	45.5 (25/55) *<0.001*

Table 4: Area of residence, childhood responsibilities/activities and schistosomiasis infection among school-age children in the Kassena-Nankana district of Ghana.

Discussion

A survey was conducted in the Kassena-Nankana district of Ghana to assess the extent and distribution of schistosomiasis infection among school-age children and establish the association between some childhood activities and the prevalence of infection. The study revealed that both urogenital and intestinal schistosomiasis infection were prevalent throughout the district. While the level of infection was found to be low (<10%) in the northern and eastern parts of the district, it was moderate (10-30%) in the western part, but high (>30%) in the southern and central parts of the district. The intensity of infection was generally low except for children resident in the central part of the district among whom the intensity of *Schistosoma mansoni* was found to be moderate.

It was not surprising that schistosomiasis infection was prevalent throughout the district, with significant differences in the level of infection from one community to another as there are numerous freshwater bodies including ponds and dugouts distributed throughout the district. Such variation in the level of infection from one part of a district to another has been observed by [14] in Senegal. In the Senegal study, low prevalence of infection was observed in communities where the water bodies dried more rapidly. Most of the dugouts in the Kassena-Nankana district dry up during the dry season; the most probable reason for the low prevalence of infection in the northern and eastern parts of the district. In the central and southern parts of the district however, is located a more permanent water body, the Tono irrigation dam. The Tono irrigation scheme has a 4 km long dam and a canal system of about 42 km. This provides a favourable environment not only for the proliferation of the snail intermediate hosts of the disease but also a convenient recreational ground for children to swim and wash clothes [5,8].

The overall prevalence of infection (*S. haematobium* + *S. mansoni*) was found to be significantly higher among males than females a situation that has been observed in many other studies in schistosomiasis endemic communities [8,14-19]. The observation by Amuta and Houmsou [15] was explained in terms of higher tendency of water contact activities among males through swimming and washing of clothes. This could be partly explained by the fact that male children are usually more adventurous and therefore more likely to play in contaminated water bodies compared to female children.

Some other studies however, could not establish any significant difference between the level of infection among male and female children [6,20]. In a study by Chipeta et al. [21] in Malawi, however, infection was higher in females than in males. Differences in the level of schistosomiasis infection between males and females have always been explained in terms of differences in water contact behaviours in relation to the frequency and duration of exposure to contaminated freshwater sources between the two sexes [6,16].

Our current study has also identified some childhood water contact activities and responsibilities like swimming, washing of clothes in the irrigation canals or dams and assisting on tomato and rice farms as major risk factors that expose children to schistosomiasis infection in the Kassena-Nankana district. A large proportion of the children indicated that they assist on tomato farms with many more of such children than those who do not (35.2% as against 21.8%) being infected. Most of the children also indicated that they swim frequently in the canals and dams, with over 70% of the males swimming frequently. Many more of the children who swim frequently in the canals, dams and dugouts were infected than those who do not (33.9% as against 17.2%). Our findings support a similar study by [20] in Ogun State, South-Western Nigeria,

where contact with stream water was found to be associated with the prevalence of urinary schistosomiasis with over 80% of those infected having been exposed to contaminated stream water.

It is important to note that some other childhood responsibilities like herding of cattle appeared to have protected the children in one way or the other from schistosomiasis infection. Caring for cattle in the field has the potential to keep children away from swimming in the canals and dams or reduce the duration of stay in the water bodies. Not much work has been done to show the relationship between herding animals in the field and schistosomiasis infection. In an earlier study by Wu et al. [22] in the lake region of China, however, herding animals was the second risk factor for schistosomiasis japonica infection after fishing. It is known that the aquatic habitats for the snail intermediate hosts for Schistosoma japonicum (Onchomelania spp) and Schistosoma mansoni and *S. haematobium* are not similar. Therefore, children herding cattle in China have a higher tendency to follow the animals into the marshy fields where the cattle are more likely to find fresh pasture thereby exposing the children to infection.

Proximity to cercariae infested freshwater bodies has also been identified as an important risk factor in the prevalence of schistosomiasis infection [6,14]. Children resident in the central and southern parts of the district were found to be more infected than their counterparts resident in the northern and eastern parts, where contaminated water sources are more seasonal. Area of residence in the district was therefore found to be very important in terms of exposure to schistosomiasis infection. A similar study by Bogoch et al. [23] in the northern region of Ghana also identified working or playing near freshwater bodies as having a significant association with *S. haematobium* infection. Such association between proximity of home or school to schistosome infested water sources and infection has been reported from many other studies in schistosomiasis endemic communities including Ethiopia [6,24], Sudan [25], Côte d'Ivoire [26] and Yemen [16,27].

Several studies including Casmo et al. [28] and Deribew et al. [29] have establish an association between the intensity of *Schistosoma* egg count and Hb concentration in similar studies. The study by Deribew et al. in Ethiopia for example, found a significantly negative correlation between egg count/intensity and haemoglobin concentration. Our current study however, could not demonstration any association between infection intensity and Hb levels, possibly because the levels of egg intensity were low.

The current study has also identified some differences in the level of infection among age groups. The level of infection was moderate (10-30%) among the younger age (6-8 years) but increased from moderate to high (>30%) among the age group 9-12 years and decreased to a moderate level among the older children (13-15 years). Such variations in the prevalence and intensity of infection among various age groups have been reported in other studies and several explanations have been given for the differences detected. Notable among these explanations is the level of water contact [30]. We agree with Tukahebwa and colleagues assertion that exposure to contaminated water alone may not explain this age difference in infection and that this pattern could be explained by slow development of acquired immunity to schistosomiasis infection with age.

In conclusion, this study has revealed that schistosomiasis is prevalent throughout the district with significant variation in the level of infection among school-age children depending on where in the district one resides. The findings support the need to put in place an integrated and effective schistosomiasis control programme. This should include annual drug administration, health education and

community mobilisation, provision of clean and safe water for domestic use, introduction of proper sanitation facilities in order to interrupt transmission and morbidity associated with schistosomiasis.

Limitations of the Study

The current level of schistosomiasis infection detected could be an underestimation of the actual prevalence of infection among school-age children, as several studies have indicated that multiple stool and urine samples or slides are needed to improve the sensitivity of the Kato-Katz and 10 ml urine filtration methods respectively [31,32]. We could however not collect multiple samples or prepare multiple slides from the single samples collected mainly due to logistical reasons. In spite of this, our findings provide a broad picture of the distribution of schistosomiasis in the district that can guide evidence-based decision making.

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