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Water Contact Activities and Prevalence of Schistosomiasis Infection among School-age Children in Communities along an Irrigation Scheme in Rural Northern Ghana

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Abstract

Of the various trematodes that infect humans, schistosomes remain among the most prevalent, and the various forms of schistosomiasis still pose significant public health problems. The prevalence of schistosomiasis infection among in-school and not-in-school children resident in communities along the Tono irrigation canals in northern Ghana was determined. Stool and urine samples from random representative samples were parasitologically examined using the Kato-Katz and 10 ml urine filtration methods respectively. A total of 920 children (mean age: 11.0 yrs; range: 6-15 yrs; STD Dev: 4.6 yrs), 573 (62.3%) males and 347 (37.7%) females with 473 in-school and 447 not-in-school participated in the study. The prevalence of *Schistosoma haematobium* infection was 33.2% (305/920) whilst that of *S. mansoni* was 19.8% (95% CI: 17.3-22.5; 182/920). The overall prevalence of infection (*S. haematobium* plus *S. mansoni*) was 47.7% (439/920). Many more males (51.7%; 95% CI: 47.5-55.8) than females (41.2%; 95% CI: 36.0-46.6) were infected. Forty-six (5.0%, 46/920) children were infected with both *S. haematobium* and *S. mansoni*. There was no difference in the prevalence of infection (*S. haematobium* plus *S. mansoni*) among children in-school (48.4%; 95% CI: 43.8-53.0) and those not-in-school (46.5%; 95% CI: 41.8-51.3). There was a statistically significant difference in prevalence of infection among communities (P=0.0002); with the lowest level of infection in residents of Korania (29.9%; CI: 20.0-41.4) and the highest among those resident in Kajelo (64.9%; CI: 51.1-77.1), with significant differences in levels of water contact activities (χ^2=6.69; P=0.04). The highest intensity of *S. mansoni* infection (115.6 epg) was in Bonia where the highest prevalence of blood stained stools was collected (5.5%). Overall, 2.8% (26/920; 95% CI: 1.9-4.2) of stool samples were blood stained, whilst 10% (92/920; 95% CI: 8.2-12.2) of children had haematuria. *S. haematobium* ova were detected in 98.9% (91/92) of blood stained urine samples. Children infected by *S. mansoni* were more likely to have blood stained stool (χ^2=32.7; P<0.0001). The prevalence of schistosomiasis infection in the irrigation project site is high, adding praziquantel to albendazole and ivermectin for distribution during the annual mass drug administration for filariasis and onchocerciasis control will be an effective way of reaching all at risk groups in the Kassena-Nankana district for the control of schistosomiasis.

Keywords: Schistosomiasis; *Schistosoma haematobium*; *Schistosoma mansoni*; Kassena-Nankana district; Tono irrigation scheme

Introduction

Human schistosomiasis, also known as bilharziasis 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 with an estimated 200 million people infected, of whom 120 million are symptomatic and 20 million have severe disease. Six hundred million people are at risk of infection [1]. The infection is prevalent in the tropical and sub-tropical areas mainly in poor communities without potable water and adequate sanitation. 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]. People become infected when the larval forms of the parasite (cercariae)-released by freshwater snails-penetrate the skin during contact with infested freshwater.

Three species of Bulinid snails are commonly found in Ghana. Of these, only *Bulinus globosus* and *B. trancatus* are known to be intermediate hosts of *S. haematobium* [3]. The third species, *B. forskalii,* even though widely distributed throughout the country, does not transmit the disease [4]. *Biomphalaria pfeifferi* is the intermediate host snail responsible for the transmission of *S. mansoni* [5,6] the parasite responsible for intestinal schistosomiasis in Ghana.

In urogenital schistosomiasis, there is progressive damage to the bladder, ureters and kidneys. Similarly, intestinal schistosomiasis results in progressive enlargement of the liver and spleen, intestinal damage, and hypertension of the abdominal blood vessels. The disease can result in other long-term irreversible consequences, including infertility [2].

Currently, interests towards the control of neglected diseases including schistosomiasis have been revived through many interventions like mass drug administration and repeated chemotherapy, to improve public health outcomes and prevent long term morbidity [2]. These actions could contribute to achieving several of the Millennium Development Goals for developing countries by the year 2015 (reduction

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in under five mortality, halt and begin to reverse the spread of Human Immunodeficiency Virus and Acquired Immunodeficiency Syndrome-HIV and AIDS, malaria and other diseases, and the eradication of extreme poverty and hunger, and universal primary education) at a favourable cost [7].

The Tono Irrigation Project, located in the Kassena-Nankana district of the Upper East Region of Ghana became operational in 1977 and has continued to provide water for all year round crop production, under the management of the Irrigation Company of Upper Region Ltd. (ICOUR) [6]. ICOUR was established by the Government of Ghana to promote the production of food crops by small scale farmers within an organized and managed irrigation scheme. The Tono dam is one of the largest agricultural dams in West Africa, with maximum storage capacity of 93×106 m3. About 2,490 hectares of land is irrigated with water from a 4km long dam which serves seven villages in the district [6]. The main crops being cultivated on the project are rice, soya bean and tomato (Figure 1). Tomato and high quality rice from ICOUR are marketed throughout Ghana whiles the soya bean is sold to industries in the country. However, the dam has also created a health problem by providing the ideal conditions for the breeding and proliferation of the intermediate host snails of urogenital and intestinal schistosomiasis [6].

Schistosomiasis is known to be associated with water-contact activities [8] like recreational (swimming) or specific agricultural activities (e.g. rice farming) [9], washing of clothes and cooking utensils [10], fishing and with the proximity of homes or communities to sites harbouring cercariae shedding *Bulinus* and *Biomphalaria* snail species [11].

The present work aimed to study the level of schistosomiasis infection among school-age children living and/or schooling in communities located along the Tono irrigation canals in the Kassena-Nankana district of northern Ghana, and to highlight the urgent need to put in place control programmes to decrease diseases associated with irrigation-based-agriculture, especially among children.

Materials and Methods

Study Site and Population

The study was conducted in the Kassena-Nankana District (KND) in northern Ghana. It covers an area of about 1,674 km^2 of Sahelian savannah with an estimated population of 144,000 [12]. 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 [13].

To enhance the research activities of the Navrongo Health Research Centre (NHRC), it has in place a demographic system, the Navrongo Health and Demographic Surveillance System (NHDSS) which records and updates demographic events including births, deaths, marriages and migrations every 120 days. This system has demarcated the district into zones (east, west, north, south and central) and clusters (244). The current study covered all communities located along the Tono irrigation canals (Figure 2). These communities are made up of 20 clusters in the southern zone and one cluster in the central zone (this did not involve sampling). The area has 12 primary and six junior high schools with the children moving from one community to another to attend school even when there are schools in the particular community for various reasons.

Sample size determination

We expected a higher prevalence rate of schistosomiasis infection (about 80%) in non-enrolled school-age children than in the enrolled children (about 70% [6]). At a confidence level of 95% and a power of 90%, a sample size of 412 each of enrolled and non-enrolled school-age children was adequate to demonstrate any differences in prevalence and intensity of schistosomiasis in school-age children in the study area. Allowing for 10% non-response, stool and urine samples were collected from a total of 920 school-age children.

Stool and urine samples collection

Stool and urine samples were collected from in-school and not in-school children resident or attending school in the study area from March-June 2008. A simple random sampling procedure was employed in which representative sample lists of eligible participants were generated from the NHDSS database. The eligibility criteria were, being aged 6-15 years, being resident in any of the communities along the irrigation canals or attending school in any of those communities. Samples were allotted proportional to the size of eligible children in the community whiles making room for lost to follow-up in the generation of the random list. The list was followed in a sequential order during sample collection until the predetermined number for the community was obtained. Non-enrolled children 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

Figure 1: Picture of a section of a tomato farm at the Tono Irrigation Project Site in Ghana.

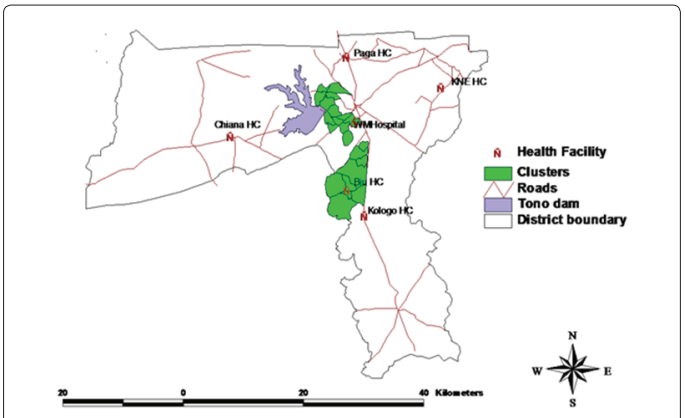

Figure 2: Map of Kassena-Nankana district showing the health facilities and the clusters in the irrigated area.

collection, which was done between 10:00 and 12:00 hours either at school or at home. Stool and urine samples were transported in ice chess with ice packs to the laboratory at Navrongo Health Research Centre for processing and examination.

Laboratory analyses

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. The Kato-Katz technique [14] was used for the estimation of the level of intestinal schistosomiasis infection. Infection was determined using optic microscopy and counting the eggs present in 41.7 mg of faeces. All samples were processed within 24 hrs of collection.

Questionnaire administration

A short questionnaire was administered to the study participants to update their school enrolment status and also capture water contact activities (bathing and washing in the canals, and working on irrigated farms). 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 [15]. 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). The prevalence and intensity of infection were tabulated against level of water contact activity 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

The protocol was submitted to the Institutional Review Board of the Navrongo Health Research Centre of the Ghana Health Service for review and approval before commencement of the study (Ethics approval No: NHRCIRBO49). Written informed consent was obtained from the parents of the study participants. Assent was also obtained from the 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. Treatment was provided for children who were found to be infected at the nearest health facility.

Results

A total of 920 school-age children (mean age: 11.0 yrs; range: 6-15 yrs; Std Dev: 4.6 yrs) participated in the study. This was made up of 573 (62.3%) males and 347 (37.7%) females with 473 in-school and 447 not-in-school (Table 1). The prevalence of *Schistosoma haematobium* infection was 33.2% (95% CI: 30.1-36.3; 305/920) whilst that of *S. mansoni* was 19.8% (95% CI: 17.3-22.5; 182/920). The overall prevalence of infection (*S. haematobium* plus *S. mansoni*) was 47.7% (95% CI: 44.4-51.0; 439/920). Many more males (51.7%; 95% CI: 47.5-55.8) than females (41.2%; 95% CI: 36.0-46.6) were infected. Forty-six (5.0%) of the children were infected with both *S. haematobium* and *S. mansoni*. The overall prevalence of infection (*Schistosoma haematobium* plus *S. mansoni*) was similar for children in-school (48.8%; 95% CI: 44.2-53.4) and those not-in-school (46.5; 95% CI: 41.8-51.3). However, the prevalence of both *S. mansoni* and *S. haematobium* as separate infections varied among children in-school and those not-in-school. Many more in-school children (24.9%) than those not-in-school (14.3%) had *S. mansoni* infection (P<0.0001). On the other hand, many more not-in-school children (38.5% than those in-school (28.4%) had *S. haematobium* infection (P=0.001).

Most of the children had light infections for the two species of *Schistosoma* (Table 1). The overall geometric mean ova intensity of *S. haematobium* for children in-school was 6.3 per 10 ml of urine and 9 per 10 ml of urine for children not in-school. That of *S. mansoni* was 95 Eggs per Gramme (epg) of faeces for children in-school and 41 epg of faeces for children not-in-school.

The level of water contact activities at the irrigation site was found to be very high as 71.4% of the children indicated that they swim frequently, 60.3% wash clothes whilst 20.4% wash cooking utensils in the canals. Assisting on tomato farms (55.4%) was a major non-recreational activity that exposed a large number of the children to schistosomiasis infection. Analysis of the water contact activities and prevalence of infection revealed that many more of the children (51.3%) who work on tomato farms than those who do not (44.1%) were infected with *Schistosoma* spp. (P=0.03) (Table 2). Bathing in the canals, washing of clothes and working on tomato farms were found to be risky water contact activities associated with schistosomiasis infection. Children who engage in all three activities in the irrigation site had a very high risk of being infected with schistosome parasites ($\chi 2$=14.62; P=0.0001).

Fifty-five percent (55%) of the children reported having ever seen blood in their urine whilst 44% indicated having ever seen blood in their stool. A significant proportion (57.6%) of the children who reported having ever seen blood in their urine were infected with *S. haematobium* (P<0.001).

Area of residence along the irrigation system was found to be

Background characteristics		*S. haematobium* infection	*S. mansoni infection*	*S. haematobium* + *S. mansoni* infection
		No infected (% infected)	No infected (% infected)	No infected (% infected)
Total population	920	305 33.2	182 19.8	439 (47.7)
Male	573	213 37.2	122 21.3	296 (51.7)
Female	347	93 26.8	60 17.3	143 (41.2)
In-school	473	134 28.4	118 24.9	231 (48.8)
Not-in- school	447	172 38.5	64 14.3	208 (46.5)

Table 1: Prevalence and intensity of schistosomiasis infection among school-age children in an irrigation community in rural northern Ghana.

Schistosoma ***spp***	**Classification of intensity**	**Schooling status**	
		In-school % infected	Not-in-school % infected
S. haematobium	Light (1-49 eggs/10 mL urine	81	84
	Moderate (50-100 eggs/10 mL urine	6	6
	Heavy ≥100 eggs/10 mL urine	13	10
S. mansoni	Light (1-99 epg of stool)	61	92
	Moderate (100-399 epg of stool)	24	8
	Heavy (≥400 epg of stool)	15	0

Total No. of children N=920					
Activity	**No. of Males who undertake activity (%)**	**No. of females who undertake activity (%)**	**Total No. of children who undertake activity (%)**	**Total No. infected (%)**	**χ^2 Yates corrected *P-value***
Bathing in the canals	442 (67.3)	215 (32.7)	657 (71.4)	333 (50.7)	24.48 <0.0001
Washing clothes	335 (60.4)	220 (39.6)	555 (60.3)	302 (54.4)	24.73 <0.0001
Washing cooking utensils	9 (7.9)	109 (92.1)	118 (20.4)	90 (47.9)	0.00 0.98
Working on rice farm	407 (67.0)	200 (33)	607 (66.0)	302 (49.8)	2.73 0.09
Working on tomato farm	236 (50.8)	228 (49.2)	464 (55.4)	238 (51.3)	4.51 0.03
Undertake at least one of the above activities	442 (59.8)	297 (40.2)	808 (87.8)	405 (50.1)	14.62 0.0001

Table 2: Various Water contact Activity and the Associated Risks of Schistosomiasis infection.

associated with the prevalence of infection among the children (Tables 3 and 4). There was a statistically significant difference between the prevalence of infection from one community to the other (χ^2=27.78; ¬P=0.0002) with the lowest level of infection found in children resident in Korania (29.9%; CI: 20.0-41.4) and the highest among those resident in Kajelo (64.9%; CI: 51.1-77.1). The prevalence of infection in children resident in Korania and Biu was much lower than their colleagues resident in Kajelo (Table 3) with significant differences in their water contact levels (χ^2=6.69; P=0.04).

The intensity of both *S. mansoni* and *S. haematobium* infection also varied from community to community with the highest intensity of *S. mansoni* infection (115.6 eggs per gramme of faeces) found among children from Bonia where the highest prevalence of blood stained stools was collected (5.5%). Children infected by *S. mansoni* were more likely to have blood stained stool than those not infected (χ^2=32.7; P<0.0001). Overall, 2.8% (26/920; 95% CI: 1.9-4.2) of stool samples were blood stained, whilst 10% (92/920; 95% CI: 8.2-12.2) of urine samples were blood stained. *S. haematobium* ova were detected in 98.9% (91/92) of blood stained urine (Table 4).

Discussion

The prevalence of schistosomiasis infection among school-age children, both in-school and not-in-school, resident in communities located along the Tono irrigation canals in northern Ghana was evaluated. Some factors associated with schistosomiasis infection among the children were also analyzed. The current paper is the second parasitological report on the schistosomiasis situation along the Tono irrigation canals since the construction of the dam over three decades ago. It is close to two decades now since the first report was published [6] and no updates have been made to provide an overview of the disease situation in the locality.

The prevalence of schistosomiasis infection among the children was high (47.7%) even though the level has reduced relative to that reported by Amankwa et al. [6] (68.7% and 67.7% for *S. mansoni* and *S. haematobium* respectively). It is important however, to note that the prevalence level detected in the current study could be an underestimation of the actual infection level, as only one sample/slide each of stool and urine per child was used for the estimation [16,17]. Similar high levels of infection have been reported among various age groups (50.6% among school-age children in Zanzibar [11]; 50.5% among infants and preschool children in Niger [18] and 58.1% among preschool children in Nigeria [19]) living in schistosomiasis endemic communities elsewhere in Africa.

The level of infection was found to be higher among males than females; a situation similar to reports from other parts of Africa [20-22]. The probable reason for the difference in prevalence of infection among males and females is the extent of water contact among the

Area of Residence	**No. of children**	**No. making water contact (%)**	**No. infected (%) (95% CI)**
Kajelo	57	54 (94.7)	37 (64.9) (51.1-77.1)
Bonia	146	141 (96.6)	84 (57.5) (49.1-65.7)
Vunania	69	48 (69.6)	37 (53.6) (41.2-65.7)
Nyangalikinia	98	84 (85.7)	51 (52.0) (41.7-62.2)
Gea	129	115 (89.1)	61 (47.3) (38.4-56.3)
Biu	216	192 (88.9)	92 (42.6) (35.9-49.5)
Gaani	128	111 (86.7)	54 (42.2) (33.5-51.2)
Korania	77	62 (80.5)	23 (29.9) (20.0-41.4)
Total	920	807 (87.7)	439(47.7)

Table 3: Area of Residence and level of exposure to Schistosomiasis Infection.

Area of Residence	**% *S. haem* Infection [95% CI:]**	**% Haematuria Intensity of *S. haem* nfection(e/10mL)**	**% *S. man* Infection [95% CI:]**	**% Blood in stool Intensity of *S. man* Infection(epg)**
Kajelo	64.9 (37/57) (51.1-77.1)	12.3 (7/57) 5.0	1.8 (1/57) (0.04-9.4)	5.3 (3/57) 24.0*
Bonia	13.7 (20/146) (8.6-21.4)	3.4 (5/146) 5.3	48.6 (71/146) (40.3-57.0)	5.5 (8/146) 115.6**
Vunania	44.9 (31/69) (32.9-57.4)	20.3 (14/69) 9.8	11.6 (8/69) (5.1-21.6)	4.3 (3/69) 48.7
Nyang-alikinia	19.4 (19/98) (12.1-28.6)	3.1 (3/98) 2.9*	40.8 (40/98) (31.0-51.2)	4.1 (4/98) 59.4
Gea	46.5 (60/129) (37.7-55.5)	7.0 (9/129) 11.0**	0.8 (1/129) (0.02-4.2)	1.6 (2/129) 48.0
Biu	38.0 (82/216) (31.5-44.8)	16.7 (36/216) 10.6	13.0 (28/216) (8.8-18.2)	1.4 (3/216) 55.7
Gaani	35.2(45/128) (26.9-44.1)	12.5 (16/128) 6.2	15.6(20/128) (9.8-23.1)	0.8 (1/128) 36.7
Korania	11.7 (9/77) (5.5-21.0)	2.6 (2/77) 4.9	14.3 (11/77) (7.4-24.1)	2.6 (2/77) 58.8
Total	33.2 (305/920) (30.1-36.3)	10 (92/920)	19.8 (182/920) (17.3-22.5)	2.8 (26/920)

S. haem =Schistosoma haematobium, S. man = Schistosoma mansoni
* lowest infection density, ** highest infection density

Table 4: Area of residence, prevalence and intensity of infection, blood in stool and urine among school-age children in communities along the Tono irrigation canals in northern Ghana.

two genders as significantly more males than females indicated swimming and washing of clothes in the canals and working on rice farms. Even though many more females than males were engaged in washing of cooking utensils in the canals, washing of utensils carried less risk in terms of exposure to infection. Such behavioral, recreational (swimming) and cultural differences in gender roles (washing of clothes and utensils, farming, etc) have been associated with schistosomiasis and other helminths (e.g. human fascioliasis) infections among males and females [20]. Even though the prevalence of infection was high among both males and females, most of them had low levels of infection intensity.

Traditionally, older children are expected to assist their parents on their farms on week-ends and during the holidays and to learn from them the art of cultivating the various crops. The cultivation of tomato in the Tono project area is done during the dry season - November/December to March/April. All the water needed for the farms is provided from the dam through an extensive system of canals. Most of the farming activities including transplanting of seedlings and the application of fertilizer for side-dressing are done while the farms are flooded. This practice exposes the limbs of the workers to contaminated water and possible infection throughout the period that they work on the farms. In the process of irrigating the farms, the water can also aid in transporting the intermediate host snails to other locations were they originally did not exist especially when the canal system breaks down.

It was not surprising that working on tomato farms was more risky than working on rice farms even though rice fields are more frequently flooded than tomato farms. There is substantial documentation that schistosomiasis transmission in most endemic areas is seasonal [6,23] and highest at the end of the rains [24]. Consequently, working on tomato farms (which is done during the dry season) is a high risk activity. Rice farming in the study area on the other hand is done mainly during the wet season. Cercariae shedding by schistosomiasis intermediate host snails and therefore schistosomiasis transmission is known to be much lower during the rainy season [25-27] and therefore the risk of infection on rice farm can be much less.

Distance of residence to the foci of schistosomiasis infection has been document to be important in the epidemiology of the disease [21]. Settlements along the irrigation system in the Kassena-Nankana district are dispersed even though some communities may be closer to the canals than others. We however believe that in addition to distance, some other factors including access to health facilities and the provision of free medication to children in some communities like Biu could have contributed to the lower level of infection. Korania is also closer to the District hospital (War Memorial Hospital-WMH) than the other communities where care and health education from the care givers could also have influenced their water contact behaviours and consequently the level of infection. The higher prevalence of *S. mansoni* infection among in-school children suggests possible foci of infection close to some schools where mainly in-school children get exposed. This is however subject to further investigation.

In conclusion, schistosomiasis infection is known to be associated with various water contact activities; swimming, washing of clothes and cooking utensils, fishing and farming [28-30] and the proximity of homes or communities to the foci of infection [5]. Most of these activities especially swimming and assisting parents on the farms are not activities that can easily be stopped among school-age children. It is well known that schistosomiasis infection among school-age children has severe short and long term adverse implications. The impact of infection on various organs (e.g. urogenital, liver and spleen) is particularly serious [24] and compromises not only the physical development, but also academic achievement both through absenteeism as well as inability to concentrate in class.

In this vein, there is the need to put in place concrete measures including regular treatment of all school-age children and other at risk groups in the irrigation communities. Adding praziquantel to albendazole and ivermectin for distribution during the annual mass drug administration for filariasis and onchocerciasis control is one sure way of reaching all at risk groups in the Kassena-Nankana district for the control of schistosomiasis [31]. It is however important to note that there are reports of tolerance and resistance to praziquantel by the parasites especially *Schistosoma mansoni* [32,33] and also the rate of re-infection after treatment is high. Other control measures including improved environmental sanitation through avoiding open defaecation, and biological control of the snail intermediate hosts need serious consideration [34].

Limitations of the study

It is worth noting that the current level of infection could be an underestimation of the actual prevalence 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 [35,36]. 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 valuable evidence required for evidence-based decision making.

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