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Schistosoma haematobium co-infection with soil-transmitted helminthes: prevalence and risk factors from two communities in the central region of Ghana

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ABSTRACT

Background: *Schistosoma haematobium* co-infection with *S. mansoni* and soil-transmitted helminthes afflict most-at-risk populations in endemic communities in the developing world. **Aim**: This study investigated *S. haematobium* co-infection with soil-transmitted helminthes, and host risk factors in two communities in the central region of Ghana. **Methods:** Schools and children were selected by stratified cluster and random sampling methods respectively. A total of 250 school children (aged 5 - > 20 years) were recruited. Teachers issued questionnaires to obtain information on host risk factors, water-contact activities and knowledge of *S. haematobium* infection. Urine and stool samples were examined for *S. haematobium* infection and *S. mansoni* and soil-transmitted helminthes using sedimentation quantitative and direct smear/formol-ether sedimentation concentration techniques respectively. **Results:** *S. haematobium* infection (1 - 50 eggs/10 ml urine) prevalence at Apewosika and Putubiw were 27.5 % and 17 % respectively. Males were more at risk of *S. haematobium* infection than females. *S. haematobium* co-infection with soil-transmitted helminthes (*A. lumbricoides*, *E. histolytica*, and *T. trichuria*) was recorded in Putubiw, with females more at risk than males. Children aged 16-19 and 10-15 were more at risk of *S. haematobium* infection and helminthic co-infection respectively. Haematuria and proteinuria were predictive of *S. haematobium* infection. School children had poor knowledge of *S. haematobium* infection. Water-contact activity was common. **Conclusion**: *S. haematobium* prevalence and its co-infection with soil-transmitted helminthes were common in Putubiw. Water-contact activity and poor knowledge about *S. haematobium* infection were major risk factors. Increased education on preventive and control measures especially in schools is recommended.

Key words: Haematuria**,** proteinuria, *Schistosoma haematobium*, *S. mansoni*, helminthes, *Bulinus globosus*

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INTRODUCTION

Schistosomiasis is a parasitic disease caused by trematodes in the genus *Schistosoma* and it is considered as a neglected tropical disease.[1,2] It afflicts millions in endemic regions of Sub-Saharan Africa, parts of Asia, and South America, precipitating abject poverty in these already disadvantaged regions. Aside malaria, schistosomiasis is the second parasitic disease accounting for significant morbidity and mortality in endemic areas.[3] Well over 207 million people are infected worldwide, out of which 85% reside in the developing world.[3] Annually, over 200,000 deaths attributable to schistosomiasis are reported in Sub-Saharan Africa.[3,4] It is reported that 3.13 million disability adjusted life years (DALYs) is attributable to the burden of schistosomiasis.[4]

Out of the five species of schistosomes known to infect humans, three (*Schistosoma mansoni*, *Schistosoma haematobium*, and *Schistosoma japonicum*) are of primary clinical importance, with urinary schistosomiasis (caused by *Schistosoma haematobium*) representing a major health threat[5] in view of its mode of transmission. Urinary schistosomiasis is transmitted in water sources infested with *Bulinus globosus* (a water snail which serve as vector for *S. haematobium*),[6, 7] therefore, proximity of communities to water sources and irrigated lands is a risk factor for exposure to infective stages (larvae and cercariae) of *S. haematobium*.[8-10] Open defecation in water sources may also increase the risk of infections.[1] Annually, 150, 000 deaths attributable to chronic *S. haematobium* infection are recorded in Sub-Saharan Africa.[11,12] Also, decreased haemoglobin (Hb) in stunted children in a study in Ghana was linked to *S. haematobium* infection.[13] In endemic communities, the high risk population includes children, the rural poor, women and the elderly who by their daily activities come into contact with water sources infested with either vectors (water snails, such as *Bulinus globosus*) which carry the infective stages (larvae and cercariae) of *S. haematobium* or the infective stages of the parasite.[14,15] No significant infection in terms of intensity and severity is observed in older adults, as both parasite burden and intensity decreases with aging.[16] It is also an important disease during pregnancy, where it may cause pre-mature birth, low birth weight and increased risk of maternal mortality.[17,18] Further, adverse health outcomes coupled with poor educational performance often observed in children suffering from *S. haematobium* infection and other parasitic diseases is projected to affect future wage earning of infected children.[19]

In Ghana, efforts have been made in terms of community education, awareness on schistosomiasis, research (prevalence, diagnosis, risk factors, risk groups, and treatment), and national integrative control initiatives with regard to fight against schistosomiasis.[1,6,7,13,19] Nonetheless, the coverage with specific reference to the above efforts in some communities which hitherto were not prone to risk of *S. haematobium* infection but have now become high risk communities due to recent human and developmental activities remains poorly investigated. Putubiw and Apewosika are two communities located near the water catchment area (Birimsu water Dam), which treats and supply potable water to the inhabitants of Cape Coast Municipality and its environs. The inhabitants of these two communities are mostly low income earners, with farming alcohol distillation, and fishing as their main livelihood. In view of the daily water-contact activities of inhabitants, especially their children, some of whom wade through water sources to and fro on daily basis to farm and school, it is suspected that these children may be exposed to risk of *S. haematobium*, since these water sources are naturally infested with water snails (vectors of schistosomes). To ascertain, and to provide first-hand information on the risk of *S. haematobium* infection in these two communities this study investigated the prevalence of *S. haematobium* and its co-infection with *S. mansoni* and other soil-transmitted helminthes among school children, and possible host risk factors in the two communities which are located at the outskirts of Cape Coast Municipality.

METHODOLOGY

Study area

Apewosika and Putubiw are in the Abura-Asebu-Kwamankese district in the Central Region of Ghana. The two communities are located in the

North-Eastern part of Cape Coast municipality, about 20 miles from the central part of Cape Coast. The communities are sited along the Kakum River and also close to the Birimsu dam. The Birimsu water treatment station supplies the entire Cape Coast Municipality and its environs with potable water. The inhabitants of these communities are mainly farmers, fisher men and alcohol distillers and therefore rely on the Kakum River for various activities of which irrigation; fishing and bathing are no exception. Although they can boast of 5 community pipes, water from the river is put to a variety of uses.

Ethics statement

Institutional research review board of the University of Cape Coast approved the study. Subsequently, permission was sought for and granted by the Ethical Review Board and the Ghana Education Service through the Head Teachers of the selected schools. Also, permission was sought from the parent-teacher association (PTA) of the selected schools, after outlining the aim and objectives of the study and explaining the mode of transmission of *S. haematobium* infection and preventive measures.

Study design

A cross-sectional study involving school children (6-20 years) from two communities was conducted from January to May, 2013. Stratified cluster sampling was used to select sample units (primary and junior high schools), whilst study subjects (school children) were randomly recruited. Subsequently, a structured questionnaire was used to solicit responses (demographic variables, behavioural activities, water-contact activities, knowledge on *S. haematobium* infection and status of sanitary facilities) from school children with the help of their class teachers. All school children who completed the questionnaire were taught how to collect samples with the help of their teachers.

Study subjects

School children between the ages of 6 and 20 years enrolled in primary and junior high schools within the two communities were randomly recruited. A total of 250 school children from Apewosika (91) and Putubiw (159) were randomly selected for the study.

Sample collection

Each study subject was assigned a serial number. Sample containers labelled with corresponding serial numbers were given to selected school children. With the help of teachers, the school children were taught how to fill sample containers with sufficient quantity of mid-stream urine and stool. Urine and stool samples were collected in the mornings (10–11 am each day). The samples were immediately kept in ice bags and transported in ice chest to the laboratory for routine analysis as previously described.[20] Samples which were not analysed immediately were stored at 4°C until use.

Physical and biochemical examination of urine samples

The physical appearance and colour of each urine sample was appraised and recorded.Urine pH, protein, leucocytes, and specific gravity were determined either qualitatively or semi-quantitatively by using urine test strips (Accubiotech Co., Ltd, China). Briefly, dipstick technique was used. By using one urine test strip/urine sample, each pre-coated urine test strip was dipped in each labeled test tube containing urine sample, allowed for 3 minutes then taking out for drying. Color changes developed on each dried urine test strip was compared to a standard color chart according to manufacturer's instruction to determine the results either qualitatively or semi-quantitatively. Also, urine inclusions (crystals, pus cells, and epithelial cells) were determined for each urine sample.

Detection of *S. haematobium* ova from urine by Sedimentation quantitative technique

Sedimentation quantitative technique was used for detection of *S. haematobium* ova in urine samples as previously described.[20] Briefly, 10 ml each of thoroughly mixed urine samples was collected into a centrifuge tube. Each centrifuge tube appropriately labelled with the corresponding sample serial number was centrifuged at 1500 revolutions per minute (rpm) for 5 minutes. The supernatant was decanted and the sediment was re-suspended and placed onto a microscope slide. A cover slip was carefully placed on the slide preparation. Mounted slides were observed under a light microscope. Initially, slides were observed using the low power objective lens (x 10) and

subsequently, using the high power (x 40) for identification of *S. haematobium* ova. The position of terminal spine was used as criteria for identification of specific *S. haematobium* ova. The number of eggs identified was quantified as number of ova per 10ml of urine sample as recommended.[20]

Detection of infective stages of soil-transmitted helminthes from stool by Direct Smear method

By using a marker, the left end of each slide was labeled with a code and drops of saline and iodine were placed on the left and right ends of slides respectively. With an applicator stick, a small portion of stool(< 1g) was picked up and added to the saline and iodine drops on the slides, then mixed in each case to form a suspension. Each drop was covered with a cover slip by holding the cover slip at 45°, touching the edge of the drop, and gently lowering the cover slip onto the slide to avoid air bubble entrapment. The preparations were examined microscopically initially by using low power (x10) and subsequently by high power (x40) objective lenses for detection of *S. mansoni* ova and infective stages of soil-transmitted helminthes (*A. lumbricoides*, *E. histolytica*, and *T. trichuria*). The number of ova detected in entire saline preparation was reported as follows: scanty (1-3 ova per preparation); few (4 - 10 ova per preparation); moderate (11-20 ova per preparation); many (21-40 ova per preparation) and very many (≥.40 per preparation) as previously described.[21-23] In view of the limited sensitivity of direct smear even in moderate and severe infections, the formol-ether sedimentation concentration technique was performed on negative stool samples from both communities.

Formol-ether sedimentation concentration technique

The formol-ether sedimentation concentration method was used as previously described [23] with some modification. Briefly, with the help of an applicator stick 2mg of stool was added to 10ml of 10 % formalin in a centrifuge tube and stirred to form a suspension, strained through a 400µg mesh sieve directly into a small beaker. The volume of the filtrate was made up to 10 ml by adding more 10 % formalin. Ethyl acetate (3 ml) was added to the filtrate and thoroughly mixed by vigorous shaking vigorously for 10seconds. The suspension was centrifuged at 3000 rpm for 1 min. The resultant suspension formed 4clearly defined zones (1. top layer of ether; 2. a plug of fatty debris adhering to the wall of the tube; 3. a layer of formalin; and 4. sediment). The plug of debris was gently loosen with an applicator stick by a spiral movement and discarded off layer 3 in a single movement, allowing the tube to drain inverted for at least 5 seconds. The remainder layers were mixed with the sediment using a disposable glass pipette. A drop of the resultant suspension was applied to a slide, and cover slipped for microscopic examination.

Statistical analysis

Data was entered in Microsoft Excel sheet and analyzed by using SPSS version 16 (SPSS Inc. Chicago. Within group means and frequencies were presented using descriptive statistics. Chi-square test was used to determine comparison of categorical variables among groups and predictive value of haematuria and proteinuria with respect to *S. haematobium* infection. $P<0.05$ was considered statistically significant in all analysis.

RESULTS

Prevalence of *S. haematobium* infection

Prevalence of *S. haematobium* infection at Putubiw and Apewosika were 17 % and 27.5 % respectively (table 1). In both communities male children and age group (16-19 years) were associated with *S. haematobium* infection (table 2). The combined prevalence of *S. haematobium* infection in the two communities was 20.8 % (52/250). The difference in *S. haematobium* infection prevalence in the two communities was significant ($P< 0.05$) statistically.

Urine characteristics

Table 3 shows the physical and biochemical characteristics of urine samples from the two communities. In both communities most urine samples positive for *S. haematobium* infection were clear. Most urine samples had no trace of crystals; however, of those which showed traces of crystals, majority had triple phosphate compared to calcium oxalate. Most urine samples from both communities had specific

gravity less than unity. Most urine samples from both communities tested positive for proteinuria, and showed pus and epithelial cells, while few samples tested positive for nitrite. Urine pH < 6 was frequently recorded in clear urine samples compared to cloudy urine samples in both communities.

S. haematobium co-infection with *S. mansoni* and soil-transmitted helminthes

There was no detected co-infection of *S. haematobium* with *S. mansoni* and soil-transmitted helminthes in Apewosika. Stool samples from Putubiw showed co-infection of *S. haematobium* with soil-transmitted helminthes (*A. lumbricoides*, *E. histolytica*, and *T. Trichuria*) but not *S. mansoni*, with school children in the 10 - 15 year group most affected (table 4). Majority of the co-infections occurred in females (table 4).

Association between proteinuria and haematuria with *S. haematobium* infection

Though limited in evidence there was association between haematuria and *S. haematobium* infection in Putubiw (χ^2 = 36.05; *P*= 0.00) and Apewosika (χ^2 = 21.566; *P*=0.001) (table 5). Similarly, proteinuria was predictive of *S. haematobium* infection in both communities (table 6). However, in both communities children who tested positive for haematuria and proteinuria were mostly those who had *S. haematobium* infection.

Table 1: Prevalence of *S. haematobium* infection in the two communities

		***S. haematobium* infection**			
Community	Number Examined*	Positive#	Negative	P-value	X^2
Putubiw	159	27(17.0)	132(83.0)	0.016	5.822
Apewosika	91	25 (27.5)	66(72.5)	0.023	3.899
Total	**250**	**52 (20.8)**	**198 (79.2)**		

* Urine samples obtained from recruited school children and tested; # 1 - 50 eggs/10 ml urine; P < 0.05 was considered statistically significant in all analysis; X^2 tested the null hypothesis that the difference between *S. haematobium* infection in the two communities is not significant

Table 2: Gender, age group and the distribution of *S. haematobium* infection in the two communities

	Putubiw			**Apewosika**		
Variables	Number* examined (n = 159)	Positive# (n = 27)	% Positive	Number examined (n = 91)	Number positive (n = 25)	% Positive
Gender						
Male	85	17	20.0	51	19	37.3
Female	74	10	13.5	40	6	15.0
Age group/years						
5-9	30	2	6.7	0	0	0.0
10-15	66	8	12.1	46	10	21.7
16-19	58	16	27.6	50	13	26.0
>20	5	1	20.0	5	2	40.0

* Urine samples obtained from recruited school children and tested; # 1 - 50 eggs/10 ml urine

Figure 3: Urine parameters and their relationship with *S. haematobium* infection in the two communities

Parameters	Apewosika		Total	Putubiw			Total
	Clear	Cloudy		Clear	Cloudy	Hazy	
	N (%)	N (%)	**N (%)**	N (%)	N (%)	N (%)	**N (%)**
Ova present	21 (26.6)	4 (33.3)	**25 (27.5)**	23 (14.5)	3 (1.9)	1(0.6)	**27(17.0)**
Ova not seen	58 (73.4)	8 (66.7)	**66 (72.5)**	120 (75.5)	12 (7.5)	-	**132(83.0)**
Crystals							
Not seen	66 (83.5)	8 (66.7)	**74 (81.3)**	123 (77.4)	11 (6.9)	1(0.6)	**135 (84.9)**
Triple phosphate	11 (13.9)	4 (33.3)	**15 (16.5)**	17 (10.7)	2 (1.3)	-	**19 (11.9)**
Calcium Oxalate	2 (2.5)	-	**2 (2.2**	3 (1.9)	2 (1.3)	-	**5 (3.1)**
Specific gravity							
<1.016	42 (53.2)	2 (16.7)	**44 (48.40**	85 (53.5)	5 (3.1)	1(0.6)	**91 (57.2)**
1.016-1.022	9 (11.4)	3 (25.0)	**12 (13.2)**	18 (11.3)	1 (0.6)	-	**19 (11.9)**
>1.022	28 (35.4)	7 (58.3)	**35 (38.5)**	40 (25.2)	9 (5.7)	-	**49 (30.8)**
Proteinuria							
Negative	44 (55.7)	4 (33.3)	**48 (52.7)**	74 (46.50)	9 (5.7)	-	**83 (52.2)**
Present	35 (44.3)	8 (66.7)	**43 (47.3)**	69 (43.4)	6 (3.80	1(0.6)	**76 (47.8)**
Pus cells							
Not seen	48 (60.8)	2 (16.7)	**50 (54.9)**	90 (56.6)	11 (6.9)	-	**101 (63.5)**
Seen	31 (39.2)	10 (83.3)	**41 (45.1)**	53 (33.3)	4 (2.5)	1(0.6)	**58 (36.5)**
Epithelial cells							
Not seen	59 (74.7)	20 (25.3)	**64 (70.3)**	108 (67.9)	12 (7.5)	1(0.6)	**121 (76.1)**
Seen	20 (25.3)	7 (58.3)	**27 (29.7)**	35 (22.0)	3 (1.9)	-	**38 (23.9)**
pH							
<6	30(38.0)	5 (41.7)	**35 (38.5)**	56 (35.2)	10 (6.3)	-	**66 (41.5)**
6 - 8.5	31(39.2)	6 (50.0)	**37 (40.7)**	68 (42.8)	3 (1.9)	1(0.6)	**72 (45.3)**
>8.5	18(22.8)	1 (8.3)	**19 (20.9)**	19 (11.9)	2 (1.3)	-	**21 (13.2)**
Nitrite							
Negative	57(72.2)	8 (66.7)	**65 (71.4)**	105 (66.0)	10 (6.3)	1(0.6)	**116 (73.0)**
Present	22(27.8)	4 (33.3)	**26 (28.6)**	38 (23.9)	5 (3.1)	-	**43 (27.0)**

Table 4: Co-infection of *S. haematobium,* with *S. mansoni* and soil-transmitted helminthes at Putubiw

Age group		Infective stages of parasites in stool sample							
		A.lumbricoides[#]		*E. histolytica*[#]		*T. trichuria*[#]		*S. mansoni*[#]	
	*Number examined	Male	Female	Male	Female	Male	Female	Male	Female
5-9	30	-	-	-	-	-	1 (4.5)	-	-
10- 15	66	-	1 (3.4)	1(2.7)	1(3.4)	-	-	-	-
16 -19	58	-	-	-	14.5)	-	-	-	-
20-24	5	-	-	-	-	-	-	-	-
Total	**159**	**-**	**1 (0.6)**	**1(0.6)**	**2(1.25)**	**-**	**1(0.6)**	**-**	**-**

*Number of stool samples examined for each year group; [#] 1 - 400 eggs or ova/g stool

Table 5: Predictability of haematuria with *S. haematobium* infection in the two study communities

Putubiw

			Intensity of *S. haematobium* infection						
			Not seen	Scanty	Few	Moderate	Many	Total	X^2 (***P*-value**)[a]
Haematuria	Negative	N	109	5	0	5	0	119	36.05 (0.00)
		%	91.6	4.2	0	4.2	0	100	
	Positive[#]	N	23	2	4	6	5	40	
		%	57.5	5	10	15	12.5	100	
Total		N	132	7	4	11	5	159	
		%	83	4.4	2.5	6.9	3.1	100	

Apewosika

			Intensity of *S. haematobium* infection							
			Not seen	Scanty	Few	Moderate	Many	Very many	Total	X^2 (***P*-value**)
Haematuria	Negative	N	56	7	4	0	1	0	68	21.566 (0.001)
		%	82.4	10.3	5.9	0	1.5	0	100	
	Positive[#]	N	10	4	2	2	3	2	23	
		%	43.5	17.4	8.7	8.7	13	8.7	100	
Total		N	66	11	6	2	4	2	91	
		%	72.5	12.1	6.6	2.2	4.4	2.2	100	

[a] tested the null hypothesis that haematuria is not predictive of *S. haematobium* infection; [#] 1 - 50 eggs/10 ml urine

Table 6: Predictability of proteinuria and haematuria with *S. haematobium* infection at the two communities

				Apewosika			
				***S. haematobium* ova**			
Proteinuria				**Seen**	**Not seen**	**Total**	X^2(**P-value**)[a]
	haematuria	Negative	N	6	29	35	4.255(0.039)
Negative			%	17.1	82.9	100	
		Positive*	N	6	7	13	
			%	46.2	53.8	100	
	Total		**N**	**12**	**36**	**48**	
			%	25	75	100	
	haematuria	Negative	N	6	27	33	
Positive			%	18.2	81.8	100	
		Positive*	N	7	3	10	
			%	70	30	100	
	Total		N	13	30	43	
				30.20%	69.8	100	
				Putubiw			
				***S. haematobium* ova**			X^2(**P-value**)[a]
Proteinuria				**Seen**	**Not seen**	**Total**	7.044 (0.008)
	haematuria	Negative	N	3	64	67	
			%	4.5	95.5	100	
Negative		Positive*	N	4	12	16	
			%	25	75	100	
	Total		**N**	**7**	**76**	**83**	
			%	8.4	91.6	100	
	haematuria	Negative	N	7	45	52	
			%	13.5	86.5	100	
Positive		Positive*	N	13	11	24	
			%	54.2	45.8	100	
	Total		**N**	**20**	**56**	**76**	
			%	**26.3**	**73.7**	**100**	

* 1 - 50 eggs/10 ml urine; [a] tested the null hypothesis that proteinuria and haematuria are not predictive of *S. haematobium* infection

Table 7: Knowledge base of study subjects on *S. haematobium* infection in the two communities

Questions	Putubiw (N=159)	Apewosika (N= 91)
Have you ever pass out bloody urine?	N (%)	N (%)
Yes	100 (63.3)	77 (84.6)
No	59 (36.7)	14 (15.4)
Do you know why sometimes we pass blood in urine or stool?		
Yes	68 (42.8)	23 (25.3)
No	91 (57.2)	68 (74.7)
What is the cause?		
Too much blood in body	1 (1.5)	3 (13.0)
Worms	8 (11.8)	3 (13.0)
Water snail	58 (85.3)	16 (69.6)
Supernatural	1 (1.5)	1 (4.3)
Toilet facilities		
WC	10 (6.3)	6 (6.6)
Pit latrine	56 (35.2)	41 (45.1)
K.V.I.P	13 (8.2)	9 (9.9)
Bush/water	38 (23.9)	14 (15.4)
Refuse dump	42 (26.4)	21 (23.1)
Domestic water source		
Stream	9 (5.7)	2 (2.2)
River	2 (1.3)	6 (6.6)
Pond	3 (1.9)	3 (3.3)
Lake	2 (1.3)	1 (1.1)
Potable water	143 (89.9)	77 (84.6)
Bore hole	-	1 (1.1)

Table 8: Responses of school children on host behaviour and water-contact activities at the two communities

Behaviour and water-contact activities	Putubiw = 159	Apewosika = 91
	N (%)	N (%)
Do you like to swim in rivers, lakes or streams?		
Yes	17 (10.7)	24 (26.4)
No	142 (89.3)	67 (73.6)
How often do you swim in rivers, lakes, or streams?		
Once a week	7 (41.2)	13 (54.2)
Twice a week	7 (41.2)	4 (16.7)
Very often	3 (17.6)	7 (29.2)
Have you ever defecated in a river, stream, pond or lake?		
Yes	5 (3.1)	3 (3.3)
No	154 (96.9)	88 (96.7)
Have you ever urinated into a river or stream before?		
Yes	7 (14.6)	8 (8.8)
No	135 (85.4)	83 (91.2)
Do you wade across water to farm		
Yes	24 (15.1)	20 (22.0)
No	135 (84.4)	71 (78.0)
How often do you wade through water to farm or school?		
Once a week	10 (41.7)	14 (70.0)
Twice a week	11 (45.8)	2 (10.0)
Very often	3 (12.5)	4 (20.0)
Do you like fishing from the river?		
Yes	13 (8.2)	18 (19.8)
No	146 (91.8)	73 (80.2)
How often do you go fishing?		
Everyday	3 (23.1)	3 (16.7)
Once a week	2 (15.4)	10 (55.6)
Twice a week	3 (23.1)	2 (11.1)
Very often	5 (38.5)	3 (16.7)
Have you ever pass out bloody urine?		
Yes	23 (14.5)	15 (16.5)
No	136 (85.5)	76 (83.5)
Do you feel pains when urinating?		
Yes	31 (19.7)	21 (23.1)
No	128 (80.3)	70 (76.9)

Knowledge of *S. haematobium* infection among study subjects

Most school children from both communities responded having passed out bloody urine, but had no knowledge of the cause (table 7). From both communities, most school children attributed haematuria to water snail infestation of water sources, while few attributed haematuria to superstition and increased body blood volume (table 7). Use of pit latrine was common in both communities, while majority of the school children had access to potable water (table 7).

Host behavior and water-contact activity

From both communities some of the school children answered in the affirmative to have waded through sources of water to farm and school, while few admitted to defecating in water sources (table 8). In both communities swimming in water sources was more common than fishing (table 8). Interestingly, the number of children who admitted to engaging in water-contact activity was small compared to those who answered negative, however the few who answered in the affirmative mostly tested positive for *S. haematobium* infection.

DISCUSSION

Relevant information on infectious and parasitic diseases, especially in endemic communities as well as most-at-risk populations is crucial for effective healthcare planning, prioritization of preventive and control measures. This study investigated the prevalence of *S. haematobium* infection,its co-infection with *S. mansoni* and soil-transmitted helminthes, and host behavioral risk factors in two communities (Putubiw and Apewosika) sited near a water source in the central region of Ghana. Importantly, the estimated prevalence of *S. haematobium* infection for Apewosika and Putubiw were 27.5 % and 17 % respectively and these estimates are lower compared to reported prevalence estimates in some endemic communities in Ghana,[9,24] especially a 95 % prevalence recorded in Bunuso.[25] The relatively lower prevalence estimated from the current study may be as a result of awareness and increasing knowledge of the mode of transmission of *S. haematobium* infection in the study area. Currently, a national average prevalence estimate for *S. haematobium* infectionis not available in Ghana. However, comparison of some reported prevalence estimates for *S. haematobium* infection from some communities together with the present prevalence estimate, it is tempting to speculate that average prevalence rate of *S. haematobium* infection in Ghana may be high despite increasing national efforts in terms of education and mass treatment. Compared with *S. haematobium* infectionprevalence estimates from some studied communities in some African countries such as in Malawi (10.4 %),[26] Sudan (0.0 %),[27] Senegal,[28] and Kenya (9.3 %),[29] that of the present study is relatively high despite been lower compared to estimates from communities in Zimbabwe (68 %),[29] Nigeria (51-59.5 %),[31,32] and Benue state in Nigeria (41.5 %).[5]

S. haematobium co-infection with *S. mansoni* and other soil-transmitted helminthes is reported elsewhere.[33] The present results showed *S. haematobium* co-infection with soil-transmitted helminthes (*A. lumbricoides*, *E. histolytica*, and *T. trichuria*) in Putubiw but not in Apewosika (table 5) and this observation is not consistent with earlier reported patterns from Kenya and other African countries where *S. haematobium* infection was shown to be co-endemic with *S. mansoni* instead of other soil-transmitted helminthes.[28,29] Interestingly, of the children who had co-infection of *S. haematobium* with soil-transmitted helminthes, majority of them were females. Whether this observation is purely per chance or has to do with female gender, requires further investigations as the present study could not explain.

Several studies have associated the risk of *S. haematobium* infection to proximity of communities to water bodies,[8,34] water sources infested with vectors (*Bulinus globosus*), and infective stages of *S. haematobium* (larvae and cercariae),[35] children and water-contact activities.[36]Consistent with these earlier reports,[34,35] the present results showed that the closeness of the two communities to the water source may probably have motivated water-contact activities, which is the main possible way by which the school children may have come into contact with the infective stages of *S. haematobium*. Notably, fishing, swimming, and wading through water were common activities which many of the school children admitted they

have engaged in at least once at a time, and these may have increased the chances of contact between the school children and the infective stages of *S. haematobium* as previously reported.[8,30,34] In support, a study from Bunuso, a community in Ghana, had shown that infestation of water sources with *Bulinus globosus* (vector which carries cercariae of *S. haematobium*) correlated with *S. haematobium* infection.[25] It is highly probable that *S. haematobium* infection in high risk groups such as school children may be as a result of water-contact activities since most water sources are naturally infested with either infective stages of *S. haematobium* or its vector (*Bulinus globosus*).

Symptomatic *S. haematobium* infection is pathologically characterized by chronic haematuria, dysuria, pollakisura, and proteinuria [26], impaired ureters and bladders, and kidney failure.[33,37] The most common and easily reported sign of *S. haematobium* infection is haematuria, while urinary analysis may also show proteinuria and leukocyturia. From this study, it was observed that most of the school children, who self-reported haematuria, also tested positive for *S. haematobium* infection and had proteinuria. Inferentially, haematuria and proteinuria, though limited in evidence was still fairly predictive of *S. haematobium* infection (table 4) and this observation is consistent with earlier reports.[29] The physical appearance of urine as well as other urine inclusions such as crystals, calcium oxalate was not of significant predictive value, though this can be investigated further.

Age of children in schistosomiasis endemic communities is suspected to be related to risk of infection.[26] Previous studies have shown that children from age 6-13 years are more at risk of *S. haematobium* infection while those above 13 years tend to have lower risk.[26] Unlike these reports,[26] it was observed that children aged between 16-19 years were more at risk of *S. haematobium* infection compared to younger children (< 15 years) (table 2) and this observation adds credence to an earlier report from Nigeria which showed that older children are more at risk than younger children.[5] With these varying reports in respect of age of children and risk of *S. haematobium* infection, it is possible that the contribution of age to the risk of *S. haematobium* infection may not be acting in isolation but may reflect on other contributing factors that influence childcare such as parental economic and social status, and educational level. This is because the likelihood of children idling, playing in water sources, wading through water to farm may depend on parental care which in itself is a function of economic status but not merely on age of children per se.

Gender is mostly perceived to be associated with *S. haematobium* infection; however, there seem to be inconsistent reports in support of this. For instance, some reports either associated males[35,38,39] or females[40] with the risk of *S. haematobium* infection while other studies reported no association between gender and the risk of *S. haematobium* infection.[41] Although limited in evidence, the present result showed high risk of *S. haematobium* infection among males compared to females in both communities (table 3), perhaps due to the aggressive nature of male children and their natural tendency to play than their female counterparts, who are relatively reserved. In view of the conflicting reports, it is necessary that a systematic and meta-analysis of independent studies on the topic be sought for, to pool together the individual evidences either in support or against gender and risk of *S. haematobium* infection.

This study was constrained by our inability to estimate *S. haematobium* vector (*Bulinus globosus*) and infective stage (larvae and cercariae) populations in the water sources and their relationship with *S. haematobium* infection in the two communities. Also, there was high drop-out rate among the selected school children leading to a relatively low sample size. It is advisable that future studies explore incentive-based methods in order to enroll more children. Notwithstanding, results of the present study provides baseline information relevant for follow up studies as well as drawing the attention of local health authorities in the study area to the problem of *S. haematobium* infection and its impact on school children.

CONCLUSION

S. haematobium infection and its co-infection with soil-transmitted helminthes in the study area especially in Putubiw was common due to poor knowledge about *S. haematobium* infection among school children and water-contact activities. Increased education on preventive and control measures especially in schools by local health authorities and other stakeholders are highly recommended.

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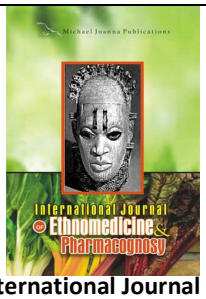

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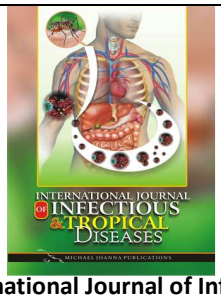

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