J Trop Med Parasitol. 2011;34:1-16.

ORIGINAL ARTICLE

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Urinary Schistosomiasis among Adults in the Volta Basin of Ghana: Prevalence, Knowledge and Practices

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Abstract

Among adults, morbidity due to the pathology of late chronic schistosomiasis infection has been reported frequently. Nevertheless, school-aged children are the main targets of schistosomiasis-control programs, because epidemiological studies often find infection to be more prevalent among school-aged children than adults. This study sought to show the importance of schistosomiasis among adult populations in the Volta Basin of Ghana. A total of 3,301 study subjects were randomly selected from 30 rural riparian communities on the Afram and Lower Volta Basin of Ghana. Urine analysis was used to determine urinary schistosomiasis infection. Subjects were also interviewed using a structured questionnaire to assess their knowledge, perceptions, and practices, in relation to the disease. The results revealed an overall prevalence rate of 46.5%. Communities on the Afram arm were 2.4 times more likely to be infected with urinary schistosomiasis than those in the Lower Volta Basin. Gender variation in prevalence was biased towards males (56.5%) compared with females (36.9%). Age-stratified prevalence was highest (73.0%) in the 15-19 year age group and decreased with increasing age to 20.8% among subjects > 49 years. Intensity of infection was generally low, and egg counts ranged between 1-1,244 eggs/10 ml urine. The arithmetic mean egg count was 0.43 eggs/10 ml of urine. Most subjects (53.4%) had no schistosome eggs in urine, 38.1% had light infections (≤ 50 eggs/10 ml urine) and 8.5% had heavy infections (≥ 50 eggs/10 ml urine). The study also demonstrated a high level of awareness of schistosomiasis as a water-borne disease, but limited knowledge of its transmission. The symptom, hematuria, was strongly associated with knowledge of schistosomiasis, whereas educational level was not. The study also revealed actions taken when infected included; doing nothing about the condition, self-medication, and visiting health facilities. This research highlights that the prevalence of schistosomiasis among adults is not transient. It is recommended that the risk groups in Ghana include adult populations in communities on the Afram arm of the Volta.

Keywords: adult schistosomiasis, prevalence, knowledge, Volta Basin, Ghana

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Introduction

Morbidity due to schistosomiasis is frequently determined by the abundance of eggs excreted in the urine or stool of infected individuals. As a result, epidemiological data often reveal the disease to be more prevalent in school-aged children and, therefore, this group is often targeted for schistosomiasis control [1]. However, much of the morbidity due to schistosomiasis is due to the late pathology of chronic infection among adults [2]. In a study conducted in Zimbabwe, it was observed that 23-41% of women who did not excrete schistosome eggs still had genital schistosomiasis [3]. In Ghana, the biomarkers of bladder cancers were more pronounced among individuals aged ≥ 30 years [4]. Also associated with chronic schistosomiasis infections are liver disease, portal hypertension, hydronephrosis, renal disease, and squamous-cell carcinoma of the cervix and bladder, all of which mostly occur in adults [2,5,6].

At the 54th World Health Assembly (WHA), held in 2000, member states were urged to achieve a minimum target of regularly de-worming at least 75% of school-aged children and other risk groups in danger of morbidity by 2010 [7]. This policy emphasized school-aged children; thus, many countries continue to focus schistosomiasis-intervention efforts mainly on children, because they are perceived to suffer most from the disease [2,8,9]. However, with increasing knowledge of the reproductive-health significance of schistosomiasis, it is important to reconsider the epidemiology of the disease, especially among adults who also happen to be the reproductive and productive component of society. Current epidemiological data on the disease in adults is therefore important, to provide the foundation for sustainable intervention efforts aimed at disease management within populations.

This paper describes the current epidemiological status of schistosomiasis in endemic communities in the Volta Basin of Ghana. It includes prevalence of the disease among adults (defined as persons aged ≥ 15 years), and community awareness and perceptions about urinary schistosomiasis.

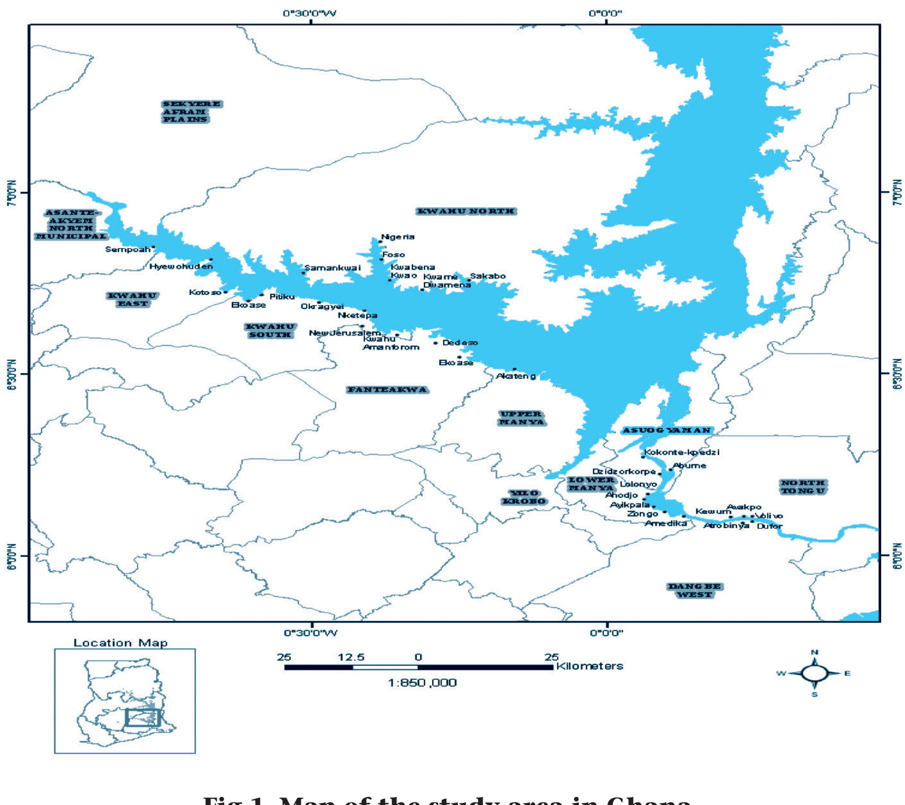

Fig 1 Map of the study area in Ghana.

Materials and methods

Ethical clearance

The Institutional Review Board of the Noguchi Memorial Institute for Medical Research (NMIMR) provided ethical clearance for the study. District health medical teams and community leaders all granted permission for the study to be undertaken, while oral consent was sought from participating subjects.

Study area and population

The study was conducted on the Afram and Lower Volta portions of the Volta Basin of Ghana. The topography of this area is generally low-lying, ranging between 80-120 m [10] above sea level. The Afram arm falls within the forest-savannah transitional zone, while the Lower Volta Basin forms part of the Accra plains, which is grassland within the coastal savannah zone. Previous work in this area revealed *S. haematobium* to be highly endemic, with > 50% of school-aged children infected [11,12].

In total, 30 riparian communities were selected for study, 17 on the Afram arm of the lake, and 13 along the river channel in the Lower Volta Basin (Fig 1). Selected communities were within 500 m from either bank of the lake or river channel, and were mainly rural.

A total of 3,301 randomly selected volunteers participated in the study. Involvement the was entirely voluntary, after community members were made aware of the study and its benefits through health education.

Sample collection and analysis

Consenting participants were given an identification number and a clean screw-capped falcon tube (50 ml), to provide urine between 10.00 am and 2.00 pm. The urine samples collected were kept in a cool box with ice packs and transported to the laboratory for analysis. The samples were analyzed for *S. haematobium* eggs by nucleopore filtration method, as described by Mott *et al* [13], and the urine sedimentation technique of Cheesborough [14].

Study participants were also administered a structured questionnaire to gather socio-demographic data and information on urinary schistosomiasis (water contact activities and knowledge, attitudes and practices). Questionnaires were administered in the local dialect spoken by study participants. The local dialects spoken in the area are Ewe, Dangme, and Twi.

Data analysis

Parasitological data were first entered into Microsoft Excel, to generate a database, which was exported into SPSS statistical software, version 18.0 (SPSS, Chicago, IL, USA). The results of the filtration and sedimentation methods were pooled for assessment of each individual's infection status. First, descriptive statistics (frequencies and cross-tabulations) were used to determine the occurrence of *S. haematobium* infection among the study population. Possible risk factors associated with *S. haematobium* infection (such as age, sex, and formal education level) were selected, based on prior studies that indicated their association with *S. haematobium* infection, then subjected to bivariate analysis. The variables that were significantly associated with schistosomiasis were then entered into a bivariate logistic regression model to predict their influence on *S. haematobium* infection. Intensity of infection was classified as light (1-49 eggs/10 ml of urine) or heavy (≥ 50 eggs/10 ml urine) [15].

All questionnaire responses were also analysed using SPSS. Responses were stratified by demographical variable–sex, age, and educational status. The Chi-square test was used to evaluate the statistical significance of bivariate associations between schistosomiasis infection and various demographic variables. Dependent variables, as to whether the subjects suffered from schistosomiasis (Yes/No), and covariates (age, sex, educational status, length of stay in the community, and knowledge about the disease) were analysed by multiple regression to explore their influence on infection. Also, the variables that might predict knowledge about schistosomiasis (signs/symptoms, mode of transmission, prevention and treatment) were assessed. Invalid and missing data were not used in analysis. All analyses were two-tailed and set at 5% level of significance.

Results

Study population profile

The demographic characteristics of the participants involved in this study are shown in Table 1. A total of 2,571 participants were administered questionnaires to assess their general knowledge of urinary schistosomiasis. Of the total respondents, 1,293 (50.3%) were males and 1,278 (49.7%) females. Participants' ages ranged between 15-89 years, and 97.2% were aged 15-49 years. The mean age of the study subjects was 29 years. More of the women interviewed (71.0%) were married than the men (47.9%) ($p < 0.01$). About one quarter of them (26.2%) were illiterate, of whom the majority (35.2%) was female. Of those who enrolled in school, only 42.7% completed primary-school education, 26.0% completed Junior

Table 1 Demographic profile of the study subjects.

Participants Characteristics	Male	Female	Total	Bivariate statistic χ^2	Bivariate statistic P-value
Age (years)					
15-19	342 (26.9)	202 (16.2)	544 (21.6)		
20-29	294 (23.1)	406 (32.6)	811 (32.2)		
30-39	294 (23.1)	362 (29.1)	656 (26.1)	48.2	0.001
40-49	206 (16.2)	254 (20.4)	460 (18.3)		
> 49	25 (2.0)	21 (1.7)	46 (1.8)		
Marital Status					
Single	634 (47.9)	282 (22.2)	900 (35.1)		
Married	618 (49.2)	903 (71.0)	1,538 (60.0)	195.3	< 0.001
Divorced	34 (2.6)	67 (5.3)	101 (3.9)		
Widowed	3 (0.2)	20 (1.6)	23 (0.9)		
Education level					
Illiterate	207 (16.6)	450 (35.2)	657 (25.6)		
Primary	574 (44.4)	526 (41.2)	1,100 (42.8)		
JSS	407 (31.5)	261 (20.4)	668 (26.0)		
SSS	82 (6.3)	29 (2.3)	111 (4.3)		
Tertiary	23 (1.8)	12 (0.9)	35 (1.4)	152.6	< 0.001
Occupation					
School	316 (24.8)	129 (9.9)	443 (17.3)		
Fishing	502 (39.4)	39 (3.0)	542 (21.2)		
Farming	161 (12.6)	263 (20.5)	424 (16.6)		
Trading	145 (11.4)	675 (52.7)	820 (32.1)		
Unemployed	66 (5.2)	80 (6.2)	146 (5.7)		
Others	85 (6.7)	97 (7.6)	182 (7.1)	846.1	< 0.001
Length of stay in village (years)					
< 1	68 (5.3)	84 (6.6)	152 (.5.9)		
1-2	72 (5.6)	61 (4.8)	133 (5.2)		
2-5	189 (14.6)	198 (15.5)	387 (15.1)		
5-10	196 (15.2)	174 (13.6)	370 (14.4)		
> 10	768 (59.4)	761 (59.5)	1,529 (59.5)	4	0.4

Secondary School (JSS), 4.3% completed Senior Secondary School (SSS) and 1.4% completed tertiary education. Fishing, petty trading, and farming, were the main occupations engaged in by the subjects. The most frequent occupation for men was fishing and women, petty trading. Only 5.8% of participants were unemployed. Most of the study participants (60%) had lived in their respective communities for > 10 years.

Prevalence and intensity of urinary schistosomiasis infection among study participants

Table 2 shows urinary analysis results of study participants. Of the total 3,301 individuals examined from all study communities on both the Afram arm and Lower Volta Basin, 1,534 (46.5%) were positive for urinary schistosomiasis (US). The prevalence rate ranged between 6.8-7.8% in the communities studied. There was a marked difference in the urinary schistosomiasis prevalence rates in the two study areas, and between genders (Table 2). Communities on the Afram arm of Volta Lake had a higher prevalence rate (59.4%) than communities in the Lower Volta Basin (29.0%) ($p < 0.001$, OR = 2.4). Males had more prevalent schistosomiasis infections (56.5%) than females (36.9%) ($\chi^2 = 127.4$, $p < 0.001$, OR = 3.4) (Tables 2,3). Subjects aged 15-19 years had the highest rate of infection (73%). As expected, prevalence rates decreased significantly with increasing age ($p < 0.001$).

The variables occupation, length of stay in the community, and water-contact activity, were all predictors of schistosomiasis infection in this study (Table 3). Individuals either at school or fishing were 2.4 and 2.8 times, respectively, more likely to be infected with the disease than those engaged in other vocations (such as welding, mechanical work, sewing, and teaching). The risk of infection among fisher-folk and school pupils was higher when adjusted for age (OR = 2.8) and sex (OR = 2.4), respectively. Logistic regression analysis found that educational level attained and marital status did not influence the acquisition of urinary schistosomiasis infection (Table 3), although there was a significant association between them and urinary schistosomiasis infection by bivariate analysis (Table 2).

Intensity of infection was generally low in the study area. Egg count ranged between 1-1,244 eggs/10 ml of urine. The arithmetic mean egg count was 0.43 eggs/10 ml of urine. Most subjects (53.4%) had no schistosome eggs in urine, 38.1% had light infections (≤ 50 eggs/10 ml urine), and 8.5% had heavy infections (≥ 50 eggs/10 ml urine) (Table 4). Using bivariate analysis, intensity of infection was significantly different between sex, age, and occupation (Table 4). Age variations in egg count are shown in Fig 2.

Knowledge and practices regarding schistosomiasis

The responses to questions related to knowledge and perceptions of schistosomiasis are presented in Table 5. Schistosomiasis was widely acknowledged (99.4%) by males and (88.7%) females ($p < 0.02$) as a disease associated with the Volta Lake/River. This knowledge varied significantly between the various occupations. Those engaged in fishing were most likely to report knowledge about the disease (94.8%), compared with those in school, who reported least knowledge about the disease (87.3%) ($p < 0.01$). Age and educational level were not found to affect this knowledge.

Blood in urine (hematuria) was the main symptom reportedly associated with the disease, followed by painful urination (dysuria) (Table 5). More women (64.6%) than men (54.4%) reported hematuria as a disease symptom, whereas for dysuria, more men reported it as a symptom (52% of men; 48% of women) ($p < 0.01$). Other symptoms, such as frequent urination and urticaria (itchy skin), were least-known symptoms of schistosomiasis infection.

Knowledge about schistosomiasis transmission varied. Over 60% of the respondents correctly stated that contact with the Lake/River was the cause of infection. This information was significantly different between the sexes. Most men (74.3%), compared with women (59.5%), possessed this

Table 2 Prevalence of *S. haematobium* infection, by demographic characteristics.

Demographic characteristic	No. infected/ No. examined	Prevalence (%)	χ^2	P-value
Location				
Afram arm	1,128/1,900	59.4	299.4	< 0.001
Lower Volta Basin	406/1,401	29		
Gender				
Female	626/1695	36.9		
Male	908/1606	56.5	127.4	< 0.001
Age category (years)				
15-19	472/647	73		
20-29	491/960	51.1	267	< 0.001
30-39	316/818	38.6		
40-49	189/561	33.7		
> 49	65/312	20.8		
15-49	1,468/2,986	49.2		
Educational level				
Primary	329/620	51.5		
JSS	186/359	51.8		
SSS	20/68	29.4	15.1	0.002
Tertiary	5/16	31.2		
Marital status				
Single	314/523	60		
Married	332/765	43.4	49.4	< 0.001
Divorced	15/56	28.6		
Widowed	2/12	16.7		
Occupation				
School	186/257	72.4		
Fishing	163/258	63.2		
Farming	108/225	48		
Trading	146/439	33.3		
Others	20/83	24.1	146	< 0.001
Unemployed	31/79	39.2		
Length of stay in community (year)				
< 1	26/77	33.8		
1-2	36/66	54.5	15.4	0.003
2-5	106/202	52.5		
5-10	106/184	57.6		
> 10	393/832	47.2		

Table 3 Risk factors for *S. haematobium* infection in the Volta Basin.

Variable	Crude OR	P-value	Adjusted OR	P-value
Location*				
Afram arm	2.4	0	2.2	0
Lower Volta Basin	1			
Gender*				
Male	3.4	0	6.1	0
Female	1			
Age category (years)*				
15-19	3	0.002	3.8	0
20-29	2.1	0.03	2	0.04
30-39	1.8	0.07	1.9	0.05
40-49	1.3	0.4	1.3	0.5
> 49	1		1	
Marital status				
Single	1.1	0.8		
Married	0.8	0.7		
Divorced	0.6	0.4		
Widowed	1			
Years in Community*				
> 10	2.3	0	2.6	0
5-10	2	0.002	1.6	0.07
2-5	2.1	0.001	2.2	0
1-2	1.4	0.21	1.9	0.001
< 1	1		1	
Water contact activity*				
Fetching water	2	0	2.9	0
Washing	2.8	0	3.4	0
Fishing	2.6	0	4.8	0
Swimming	3.4	0	4.2	0
Farming	2.2	0.03	3.7	0
No water contact	1		1	
Educational level				
Primary	1.2	0.19		
JSS	1	0.75		
SSS	1.2	0.5		
Tertiary	1	0.9		
Illiterate	1			

Note: Unmarked variables were not adjusted for in the model, because they were insignificantly associated with infection; *The variable location was adjusted for sex, age and occupation; Age was adjusted for sex, occupation, and water-contact activity; Gender was adjusted for age, water-contact activity; Occupation was adjusted for age and sex; Length of stay in the community was adjusted for age, sex and occupation; water-contact activity was adjusted for age and sex.

Table 4 Intensity of *S. haematobium* infection, by gender, age, and occupation.

Variable	Intensity of infection (%)			Total examined	P-value
	No eggs	Light	Heavy		
Gender					
Male	685 (44.2)	674 (43.5)	191 (12.3)	1,550	< 0.001
Female	1,042 (63.0)	529 (32.0)	82 (5.0)	1,653	
Schistosomiasis status					
Positive	2 (0.1)	1,194 (81.3)	272 (18.5)	1, 735	< 0.001
Negative	1,725 (99.4)	9 (0.5)	1 (0.1)	1,468	
Age category (years)					
15-19	167 (26.6)	298 (47.8)	164 (26.1)	629	
20-29	460 (49.7)	403 (43.5)	63 (6.8)	926	< 0.001
30-39	491 (61.9)	275 (34.7)	27 (3.4)	793	
40-49	367 (67.0)	169 (30.8)	12 (2.2)	548	
> 49	242 (78.8)	58 (18.9)	7 (2.3)	307	
Occupation					
School	76 (29.6)	119 (46.3)	62 (24.1)	257	
Fishing	105 (40.7)	135 (52.3)	18 (7.0)	258	
Farming	117 (52.0)	92 (40.9)	16 (7.1)	225	< 0.001
Trading	302 (68.8)	127 (28.9)	10 (2.3)	439	
Unemployed	49 (62.0)	23 (29.1)	7 (8.9)	79	
Others	67 (80.7)	15 (18.1)	1 (1.2)	83	
Total	53.4	38.1	8.5		

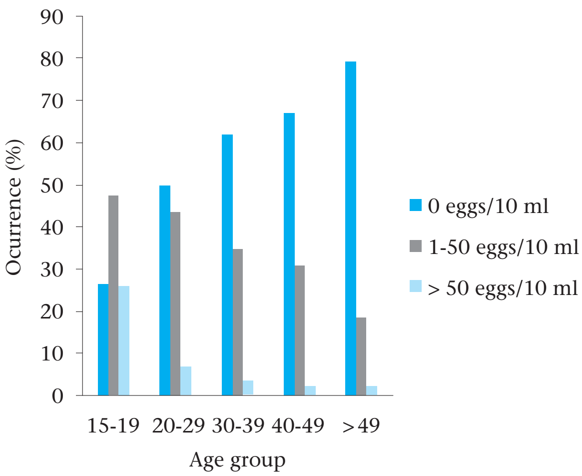

Fig 2 *S. haematobium* egg counts/10 ml urine, stratified by age.

knowledge. However, knowledge did not differ significantly between the different educational levels attained or between different age groups ($p > 0.05$). Strikingly, 36.5% of men and 22.2% of women indicated that they did not know the source/cause of infection. Some misconceptions about disease transmission were that it was caused by sexual transmission or was a punishment from God.

Knowledge of schistosomiasis prevention was generally low (Table 5). Only 35.4% of males and 24.7% of females knew that avoiding water contact was the best way to prevent infection. Some (22.5% of men; 25.2% of women) also believed that taking drugs could prevent infection. Overall, more fisher-folk answered questions about transmission, except for symptoms, where more of the unemployed reported hematuria as a symptom (Table 5).

Table 5 Reported knowledge about urinary schistosomiasis.

Respondent's knowledge about schistosomiasis	Percentage of respondents who reported knowledge of urinary schistosomiasis, by gender, educational level, occupation, and age group													
	Gender** (N = 2,553)		Educational level attained (N = 1,901)				Occupation* (N = 2,554)						Age group (years)	
	Male	Female	Basic	JSS	SSS	Tertiary	Unemployed	Schooling	Fishing	Farming	Trading	Others	15-24	> 24
Acknowledge schistosomiasis as a disease	99.4	88.7	91.8	89	91.9	97.1	93.2	87.3	94.8	91.7	87.7	87.4	86.9	91.9
Knowledge of Symptoms														
Blood in urine	54.4	64.6	61.3	59.2	46.8	54.3	70.5	51.9	57.2	61.6	63.4	70.5	55.5	62
Frequent urination	0.9	0.5	0.8	0.6	2.7	0	0	0.5	1.1	0.9	0.7	0	0.6	0.8
Painful urination	52	48	3.4	2.9	2.7	2.9	8	13.3	30.7	22.7	24	1.3	41.3	58.7
Fever	0.3	0.2	0.1	0.2	0	0	0	0.5	0	0.5	0.4	0	0.4	0.2
Skin itch	1.6	0.3	1.2	1.1	0	0	0	2.3	4.2	4	2.2	1.3	0.3	0.7
Don't know	37.5	62.5	8.1	8.3	5.4	0	7.5	7.9	6.1	9.7	11	7.7	9.8	8.1
Mode of infection														
Contact with lake	74.3	59.5	69.6	72	74.8	80.8	69.9	73.6	73.4	63.9	59.3	69.2	67.6	66.3
Drinking lake water	2	2.8	2.2	2.9	2.7	5.7	0.7	1.8	2	5.9	1.6	2.2	2.3	2.4
Eating sugarcane	0.3	0.2	0.1	0.2	0.9	0	0.7	0.2	0.2	0.2	0.2	0	0.3	0.2
Sexually transmitted	1	0.8	1	0.5	1.8	0	0	0.5	1.3	0.7	1.2	0.5	0.6	1.1
Don't know	36.5	22.2	26.8	24.5	19.8	14.3	28.8	23.9	23.1	28.8	37.4	27.5	29.1	29.7
Mode of prevention														
Avoid contact	35.4	24.7	32.9	33.4	40.5	34.3	28.8	38.8	33.4	26.4	25.2	30.2	32.9	28.3
Medication	22.5	25.2	24.7	22.4	21.6	22.9	20.8	31.2	25.8	21.9	24.1	22	22.4	24.7
Aquatic-weed clearing	1	0.7	0.2	0.8	0	0	0	0.7	1.3	0.9	0.7	1.1	0.8	0.9
Drink uninfected water	5.2	4.3	3.7	6.2	12.6	2.9	3.4	4.3	4.4	5.9	5.1	3.3	3.7	5.4
Don't know	16.3	19.7	18.3	15.9	3.6	11.4	13.7	14.2	16.8	21.5	20.2	15.9	18.1	17.9

Note: N = No of respondents to each question; * = Factors with P-value < 0.01; ** = Factors with P-value < 0.02

Health-seeking behaviors

To determine respondent's health-seeking behaviors towards the disease, it was necessary to confirm whether the subjects had ever suffered from urinary schistosomiasis. A total of 1,379 (54%) respondents acknowledged having suffered from the disease. Of these, 951/1,291 (73.7%) were males, and 439/1,278 (34.4%) females ($p < 0.01$).

Of these respondents, two cohorts were analyzed for the action they took when they suffered from the disease; those with symptoms during the study period (SWS) and those who had suffered the disease but were not showing symptoms at the time of this study (SWOS). The actions taken by these cohorts are shown in Table 6.

Between the two cohorts of respondents, doing nothing about the condition, visiting a health facility, and self-medication, were commonly reported. For instance, 38.5% of males and 39.5% of females showing symptoms during the study period did nothing about their health condition, while 23.3% of males and 29.7% of females self-medicated and 23.3% of males and 29.7% of females visited a health facility. Among those without symptoms, 12.3% of males and 17.2% of females acknowledged not doing

Table 6 Health-seeking behaviors related to schistosomiasis infection.

	Action taken in response to schistosomiasis symptoms (%)											
	Nothing		Self-medication		Herbalist		Health facility		Spiritualist		Total Respondents	
	SWS	SWOS	SWS	SWOS	SWS	SWOS	SWS	SWOS	SWS	SWOS	SWS	SWOS
Gender												
Male	38.5	12.3	33.8	33.7	3.8	6.4	23.3	47	0.6	0.5	527	389
Female	39.5	17.2	24.6	27.2	6.2	5.7	29.7	48	0	0.6	195	261
p = 0.06*, p = 0.17**												
Educational attainment												
Primary	38.4	15.2	30.7	30.1	5.3	6.9	25.4	47.1	0.3	0.3	323	289
JSS	43.3	9.5	32.4	32.7	2.4	3.6	21.9	54.2	0	0	210	168
SSS	17.6	5.6	23.5	22.2	2.9	5.6	55.9	66.7	0	0	34	36
Tertiary	33.3	20.1	0	40	0	0	66.7	40	0	0	3	10
p = 0.014*, p = 0.41**												
Length of stay in community (year)												
< 1	51.3	17.6	25.6	26.1	0	13	23.1	43.5	0	0	39	23
1-2	51.2	16.7	25.6	37.5	4.7	0	18.6	45.8	0	0	43	24
2-5	41	18	31.6	31.5	6.8	5.6	20.5	44.9	0	0	117	89
5-10	48	14.8	28.1	37.5	2.6	6.8	21.1	40.9	0	0	114	88
> 10	33	13.1	33.3	29.6	4.6	6.1	28.4	50.7	0	0	409	426
p = 0.14*, p = 0.89**												

Total respondents who acknowledged suffering disease = 1,390/2569 (54.1%); Number of males acknowledged suffering disease = 951/1291 (73.7%); Number of females acknowledged suffering disease = 439/1,278 (34.4%); SWS = subjects with symptoms; SWOS = subjects without symptoms; *P-value = subjects with symptoms during the study period; **P-value = subjects without symptoms during the study period; *p = 0.014 = significant P-value showing a positive influence of educational attainment on health action taken anything about their condition, while 33.7% of males and 27.2% of females self-medicated, and 47% of males and 48% of females visited a health facility. There was, however, no marked difference in the action taken by males and females in both cohorts. Furthermore, action taken by the two groups was not influenced by length of stay in the community. However, educational level attained influenced action taken among SWOS ($p = 0.014$). Generally, more subjects with higher educational attainments visited health facilities than those with lower educational attainments (Tertiary = 66.7%; SSS = 55.9%; JSS = 21.9%; Primary = 25.4%). Interestingly, the use of herbal potions and spiritual healing was very limited among the study population.

Subjects who did nothing about their health condition were asked about their decision. Costs were the main reason for not seeking healthcare; 74.4% felt seeking healthcare was expensive. Other reasons, such as distance from a health facility (4.8%), unavailability of a health facility (2.8%), and previous side-effects of treatment (2.5%), were low (Table 7).

Table 7 Reported reasons for not seeking healthcare.

Reason	Number	Percentage
Expensive	656	74.4
Far away	42	4.8
Waste of time	61	6.9
Previous side-effect	22	2.5
No health facility	25	2.8
No reason	76	8.6

Discussion

Many epidemiological studies on schistosomiasis have been conducted with school-aged children and/or whole populations [16,17], but limited studies have focused only on adult populations. This study measured the occurrence of urinary schistosomiasis among adults aged ≥15 years in riparian communities of the Volta Basin, and assessed their knowledge, perceptions, and practices, towards the disease. This was done to assess the contemporary situation of urinary schistosomiasis among adults in the study area a when the control of neglected tropical diseases, including schistosomiasis, was ongoing in Ghana.

The prevalence of urinary schistosomiasis among the study population was 46.6%. This was higher than expected, as adults in endemic communities on average have prevalence rates of about 20.0% [18]. A recent study conducted in 3 villages northwest of Accra found 15.5% of adults to be infected with urinary schistosomiasis [19]. Likewise, Nmorsi *et al* [20] found 20% of adults, in their Nigerian study, to be infected with the disease. The high prevalence of *S. haematobium* infection observed is not surprising, as communities in the study area continue to depend heavily on the Volta Lake and River for fishing, water supply, transportation, and recreation [21], thereby being exposed to the infective forms of the parasite (cercariae). Due to an explosive increase in aquatic vegetation, which supports the proliferation of schistosomiasis intermediate-host snails in the Volta River system [22,23], schistosomiasis transmission has been sustained in the study area since the lake was formed.

Schistosomiasis infection is focal in distribution, so that variations in prevalence rates are expected. However, the marked differences in prevalence rates between communities on the Afram arm (59.4%) and the Lower Volta Basin (29.0%) ($p < 0.001$) draws attention to the importance of the disease among adults, especially among communities in the upper reaches of the Volta Basin.

As early as 1966, following the construction of the Akosombo Dam and the formation of the Volta Lake, intense schistosomiasis transmission was observed in the flooded valleys of the Afram, Obossum, Sene, and Pru Rivers [24]. This was confirmed by high urinary schistosomiasis prevalence rates (90%) found among children in the area [12]. Little economic development has occurred in the Afram area since the 1960s.

It continues to be less endowed with social infrastructure—roads, potable water, electricity, hospitals, and other basic amenities—than the Lower Volta communities, which are closer to the capital city of Accra and seem to benefit more from developmental projects.

Secondly, schistosomiasis control programs through the health delivery systems all came to a standstill after donor support dwindled over the years after the dam's construction. Presently, the Volta River Authority (VRA) is the only institution known to actively engage in schistosomiasis treatment as a control measure in the study area. Even though their mandate is to service only resettlement communities, they often extend their services to other communities along the lakeside. Informal discussions with members of the Afram communities indicated that the VRA treatment boat had not come into their communities for many years, because of difficulty navigating the Volta, where there are many submerged tree stumps. Thus, it is likely that the most of these communities have not been treated for schistosomiasis for many years.

As in other earlier studies [25,26], there was a marked difference between infected men (56.5%) and women (36.9%) ($p < 0.001$) by urinalysis. This may be explained by the cultural habits of regular and longer water-contact by men, through fishing and swimming, than their female counterparts, who were mainly engaged in fetching water and washing. Previous studies revealed a significant association between the risk of infection and duration of contact with infected water [27,28], as well as age and intensity of water contact [29,30]. From this study, the risk of acquiring infection was highest while swimming (crude OR = 3.4), followed by washing (crude OR = 2.8), fishing (crude OR = 2.4), and fetching water (crude OR = 2.0). The finding supports the suggestion that swimming posed a higher risk of schistosomiasis infection than fetching water, because it involved the total body immersion for longer periods at peak periods of cercarial shedding, while fetching water was done in the early hours of the day, when cercarial shedding was minimal [31]. Our study also found younger adults, 15-29 years, harbored more infections than their older counterparts. The increased risk of infection among younger adults may be explained by the fact that they tended to have frequent contact with water, by fetching lake water, washing, bathing, and swimming, compared with older persons. In Ghana, persons, aged < 26 years, were found to be at increased risk of schistosomiasis infection, probably because of fetching water, bathing, and swimming in water bodies [32].

Intensity of infection, determined by egg count, was generally very low, with > 50% of subjects' not excreting eggs in urine. The majority of those excreting eggs in urine showed light infection intensities (< 50 eggs/10 ml urine). This was expected, as a number of factors had earlier been reported to influence intensity of schistosomiasis infection among adults, including age, decline in water-contact activity, and concomitant immunity as a result of previous infection [33-35]. Within populations resident in schistosomiasis-endemic communities, children are generally seen to be more heavily infected than adults. Intensity of infection rises in childhood, peaks in the early teenage years, then rapidly declines with increasing age. At puberty, hormone levels rise and these may have a direct influence on parasite metabolism, induction of anatomical and physiological changes in the host that may result in an increased innate resistance to infection, and induction of changes in the immune system to increase the likelihood of protective immunity [34]. In addition, the behavioral patterns of boys and girls are diverge around puberty, giving rise to differences in exposure levels over many years [33]. Decline in water contact activity with increasing age may also influence intensity of infection, but some studies suggest the decline in activity alone is insufficient to account for marked reduction in intensity with age, especially after treatment [33,36]. In other words, resistance to schistosomiasis infection is believed to be largely mediated through the immune system of the human host.

Contrary to observations by Kloos [37], who found only 25.8% of subjects associating the disease with infected water, there was a high level of awareness (99.4% of males; 88.7% of females) of schistosomiasis as a water-borne disease among riparian communities in the Volta Basin. However, comprehension of the mechanism of transmission was unknown to many of them, even after several decades of identifying the area as an endemic focus for the disease [11,12,23,24]. The fact that the study population associated the disease with the water body may be ascribed to experience with, or awareness of, health risks associated with water. On the other hand, limited knowledge about disease transmission may reflect the general level of health literacy in the study area. Health literacy is defined as "the cognitive and social skills that determine the motivation and ability of individuals to gain access to understand and use information in ways which promote and maintain good health" [15]. Many of the subjects in this study had dropped out of school at the basic level. This was deduced from the high number that had enrolled in school (74.4%), of whom only 42.8% completed primary-level education. It was also observed that most of the subjects had limited reading and writing abilities, a situation invariably having implications for their appreciation of health information. Despite the fact that education is imperative in understanding health issues, knowledge and perception do not always necessarily lead to behavioral change. Even if awareness about the risk of infection with schistosomes is improved, people still have to resort to cercaria-infested rivers and lakes for water supply [38,39], so that, schistosomiasis infection will be perpetuated. This may be why Wagatsuma *et al* [40] found that highly symptom-aware children were heavily infected with urinary schistosomiasis in southern Ghana. Other factors, such as socio-economic status, cultural beliefs, ignorance, and religion, have all been suggested to influence schistosomiasis transmission significantly [39].

Issues of recall have been raised regarding questionnaire-based assessments of schistosomiasis infection and symptom reporting [41]. However, van der Werf *et al* [42] showed that this was not important in the case of urinary schistosomiasis infection, no time-related effect on recall for reporting blood in urine. As such, this study did not take the period of recall into account. Hematuria and dysuria were symptoms frequently reported to be associated with schistosomiasis infection. Other symptoms, such as frequent urination, urticarial, and fever, were, however, hardly known as symptoms of the disease. This was not surprising, since these are not specific to schistosomiasis. Self-identification of symptoms and signs of schistosomiasis was assumed to influence treatment-seeking behaviors for schistosomiasis infection [43]. However, individuals infected with urinary schistosomiasis were generally found to show a very low tendency to seek care for their condition, compared with those with fever or even intestinal schistosomiasis [44].

Health-seeking behaviors are influenced by complex multidimensional factors; many studies have identified, among others, perceived severity of schistosomiasis as a significant factor influencing healthcare seeking behavior [41,43-46]. Although this study did not clearly assess the perceived severity of urinary schistosomiasis, it may be an important factor influencing health-seeking in this study area. De Vlas *et al* [47] found, in their study in Ghana, a low turnout for passive case findings by health officials (< 5% cases of blood in urine received praziquantel), mainly because of the low tendency of symptomatic cases to seek health care.

Among these study participants, the cost of seeking health care was the most frequently reported reason for not seeking care. This result was expected, because the study started when the National Health Insurance Scheme (NHIS) had just been introduced, to replace the previous "cash and carry" system of payment for health delivery services, which required patients to pay the full cost of registration, consultation, diagnostics and treatment. Most community members in Ghana are yet to really understand the benefits of registering with the NHIS. The impacts of the NHIS on schistosomiasis-related healthcare-seeking behaviors require further study. Self-medication using allopathic drugs sold by drug peddlers was an important means by which schistosomiasis was treated by the affected individuals. This study however, did not identify the names of the drugs sold to them, so that it is difficult to know whether schistosomiasis-infected individuals received appropriate treatment through self-medication. Nevertheless, the likelihood that drugs bought from peddlers was not praziquantel was high; Danso-Appiah *et al* [41] revealed that over 90% of people who self-medicated or visited a pharmacy for treatment did not receive praziquantel. They also showed no known traditional medicine existed for treating schistosomiasis-related symptoms. This raises serious public-health concerns, since it is unlikely that self-medication helps control morbidity in schistosomiasis.

From this study, it can be hypothesized that riparian community members living on the Afram arm of the Volta Basin are at higher risk of chronic schistosomiasis infection than those in the LVB. It is recommended that schistosomiasis treatment among adults in the area should be considered urgently, to forestall the consequences of complications. VRA alone cannot support this venture and, therefore, the Ghana Health Service must be encouraged to refocus attention on schistosomiasis control in the Volta Basin and the country as a whole.

Health education is also necessary to raise awareness of early treatment of schistosomiasis-related symptoms, the consequences of untreated schistosomiasis infection, and to encourage symptomatic cases to seek proper treatment for the condition.

Acknowledgements

The authors sincerely acknowledge the funding agencies, Ghana AIDS Commission and DANIDA through the Ministry of Water, Works and Housing. We are also grateful to the district health management teams, community leaders and study participants for their collaboration with the research team. Also recognized are the contributions of the Public Health team of VRA, VBRP, and NMIMR technicians (Parasitology Department).

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