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Prevalence of schistosomiasis among school children at Esuekyir community in the Central Region of Ghana

Denzel Opoku-Kwabi[1], Belinda Sevor[1], Emmanuel Adu Sarpong[1], Pius Kwasi Sam[1], Abigail Agyen Frimpong[1], Porschier Aninagyei Marfo[1], Michael Asare[1], Emmanuella Akumeniwaa Nkrumah[1], Bernard Boakye Badu[1,2], Alberta Serwah Anning[1] and George Ghartey-Kwansah[1*]

Abstract

Schistosomiasis, an endemic neglected tropical disease in areas with poor sanitation, causes physical and mental defects in both children and adults. Various strategies, especially drug administration for morbidity control, have been implemented to combat the disease in Ghana and globally. Despite these efforts, schistosomiasis remains prevalent in Ghana, negatively impacting children's academic performance, growth, and overall quality of life. This study aimed to determine the prevalence of schistosomiasis in school children at Esuekyir, a peri-urban community in Ghana. A cross-sectional study using simple random sampling technique to select participants and collect stool and urine samples from 246 school children in Esuekyir was adopted. Microscopy of urine and stool samples was performed involving urine sedimentation and stool formol-ether sedimentation techniques to analyse for parasite eggs. Questionnaires were developed to help detect risk factors that expose these children to the disease.

The prevalence of urogenital schistosomiasis in children at Esuekyir was 15.45% while that of intestinal schistosomiasis was 6.957.0%. There was one case of co-infection of urogenital and intestinal schistosomiasis from a 13 year old primary student. Children in primary school had higher risks of infection due to their activities around the water body. There was a significant association between class groups and urogenital schistosomiasis (*p*-value = 0.042).

The presence of schistosomiasis in school children highlights the importance of targeted interventions and public health initiatives in addressing this specific disease condition especially in primary school children. Findings from the research revealed a higher prevalence of urogenital schistosomiasis in the study population as compared to intestinal schistosomiasis.

Keywords *Schistosoma haematobium*, *S. mansoni*, Urogenital schistosomiasis, Intestinal schistosomiasis

*Correspondence:
George Ghartey-Kwansah
george.ghartey-kwansah@ucc.edu.gh
[1] Department of Biomedical Sciences, University of Cape Coast, Cape Coast, Central Region, Ghana
[2] Twifo Atti/ Morkwa District Hospital, Twifo Praso, Central Region, Ghana

Introduction

Schistosomiasis, a neglected tropical disease common in areas with poor sanitation, causes physical and mental defects in both children and adults [16, 22]. Strategies, primarily focused on drug administration, have been implemented to control the disease in Ghana and globally [23]. However, schistosomiasis remains prevalent in Ghana, negatively impacting children's academic performance, growth, and overall quality of life [16]. The species of *Schistosoma* found in Africa are*, S. haematobium, S. mansoni* and *S. intercalatum* [10, 19]. In Ghana, however, only two species, *S. haematobium* and *S. mansoni* have been identified [4].

The major health complications with regard to *S. haematobium* and *S. mansoni* are urogenital and intestinal schistosomiasis respectively [14]. Intestinal schistosomiasis has been characterized by abdominal pain, diarrhoea and haematochezia [29], whereas urogenital schistosomiasis is characterised by haematuria, abdominal pain, and discomfort when passing urine [18]. Chronic schistosomiasis can also trigger pro-inflammatory immune response, resulting in anaemia which occurs through mechanisms such as dyserythropoiesis and iron sequestration [11].

Socio-economic factors influence the prevalence of schistosomiasis by reducing access to clean water sources, sanitary facilities, and healthcare services [24]. Addressing the underlying socio-economic determinants is crucial for sustainable control of schistosomiasis within the community of Esuekyir. Community engagement and collaboration with local stakeholders are essential to overcome socio-economic barriers and ensure the effectiveness of interventions.

Prevalence studies of this nature will help advice as well as direct specific and targeted interventions focussing on specific risk factors which may be more effective than just Mass Drug Administration (MDA).

Materials and methods

Study sites

The study was carried out in the Adisadel Sub-district in the Cape Coast Metropolis of the Central Region of Ghana, specifically at Esuekyir. The Cape Coast metropolis is mainly drained by the Kakum River, which serves as the main source of water for farming, domestic chores and recreational activities for towns like Esuekyir, Kakumdo and Kwaprow.

Sample size

The sample size was determined statistically as $n = 246$. This was calculated using a confidence interval of 95% ($z = 1.96$), a margin of error of 0.05 and an average estimated prevalence of 20% from other studies.

Study design

This was a cross-sectional study conducted from March 2023 to September 2023. Study participants were randomly selected from Esuekyir M/A School. Two hundred and forty-six (246) school children including 130 males and 116 females, were voluntarily enrolled.

Inclusion and exclusion criteria

School children aged 4 to 19 years currently attending Esuekyir M/A School were selected. There was no exclusion criteria.

Questionnaire collection

Structured questionnaires developed specifically for this study [see Additional file 1] were administered to obtain information on participants' socio-demographic characteristics, predisposing factors, and knowledge of urogenital and intestinal schistosomiasis. Each questionnaire was assigned a unique number for each participant, and its completion was checked.

Specimen collection

Sterile urine and stool containers (one each) labelled with the assigned numbers were given to selected school children. Approximately 15-20 ml of fresh urine and 5-7 g of fresh stool samples were collected and immediately kept on ice to preserve and protect the integrity of the sample. The samples were transported to the Department of Biomedical Sciences laboratory for analysis, where routine analysis were carried out. It took approximately 3 h from sample collection to lab processing.

Microscopic examination

Urine microscopy was conducted using the urine sedimentation method as described previously by Abosalif et al. in 2019 [3]. Briefly, 10 ml of the collected urine samples were centrifuged at 3000 rpm for five minutes. The supernatant was discarded while the deposits were placed on a slide, covered with a cover-slip and examined using a light microscope. Formol-ether sedimentation was used to microscopically examine the stool samples [12]. Five millilitres (5 ml) of the faecal suspension was strained through a gauze into a 15 ml centrifuge tube and topped up with 10% formalin to bring the final volume to 15 ml. The sample was centrifuged at 3000 rpm for 10 min. The supernatant was discarded and 10 ml of 10% formalin was added to the sediment and mixed. Afterwards, 4 ml of ethyl acetate was added to the sample, shaken vigorously for 30 s and centrifuged at 3000 rpm for 10 min. The top layers were decanted and the sediments were then suspended with a drop of 10% formalin, and thence mounted on a slide and covered with a cover-slip. Slides were subsequently observed under a light microscope using the $\times 40$ objective lens. Samples containing *Schistosoma* eggs were then identified and recorded.

Statistical analysis

All data collected were entered and cleaned in Microsoft Excel 2010 and analysed using Statistical Package for

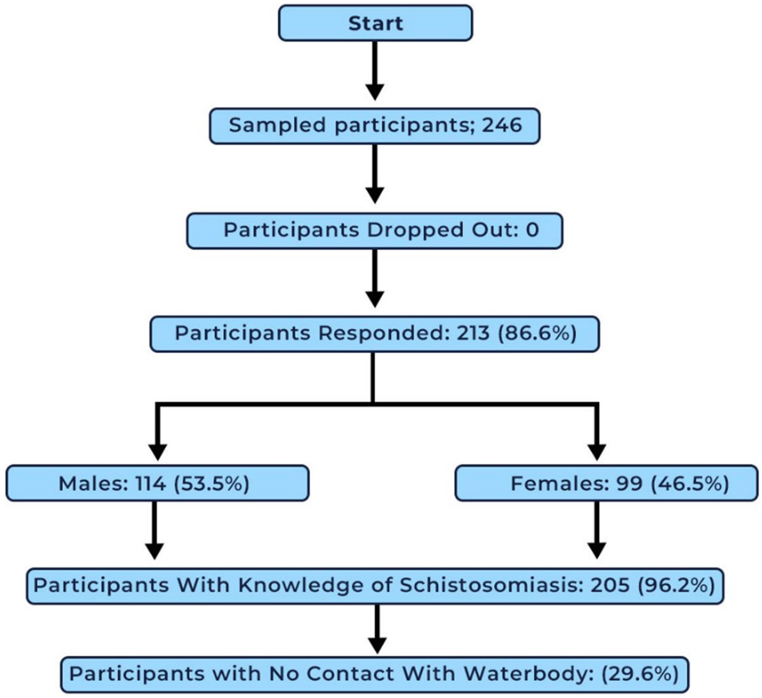

Fig. 1 Flowchart of participants' sampling and response rates

Social Science (SPSS) version 20. They were then summarized using frequency and cross-tabulation of descriptive statistics. Chi-squared tests were employed to identify the factors that were significantly associated with schistosomiasis. ANOVA test was performed to determine the differences across class and age groups in relation to the schistosomiasis cases while logistic regression was employed to determine the relationship of the condition to some of the proposed associated risk factors.

Results

Characteristics of the study population

A total of 246 participants comprising 130 (52.8%) males and 116 (47.2%) females were included in the study. Two hundred and thirteen (213) representing 86.6% of the 246 participants responded to the questionnaires with 114 (53.5%) being males and 99 (46.5%) being females (Fig. 1). Out of these respondents, 205 (96.2%) indicated that they had prior knowledge and had been educated on schistosomiasis. Also, 64 (29.6%) of the respondents indicated they had no contact with the river or had not been exposed to any other water body (Table 1).

Prevalence of urogenital schistosomiasis

Out of the 246 participants (130 males and 116 females), 38 representing 15.5% tested positive for urogenital schistosomiasis. These 38 positives consisted of 23 males and 15 females, representing a prevalence of 17.7% ($n=23/130$) for males and 12.9% ($n=15/116$) for females as indicated in Table 2.

In order to ascertain the risk of contracting schistosomiasis among age or class groups, the sample population was divided (Table 3). The prevalence of urogenital schistosomiasis does not show a statistically significant variation across different age groups but shows a statistically significant variation across different class groups, with primary school pupils showing the highest percentage of positive cases (p-value = 0.042).

Prevalence of intestinal schistosomiasis

Out of the 115 participants (59 males and 56 females), who submitted stool samples, 8 representing 7.0% tested positive for intestinal schistosomiasis. The 8 positives consisted of 6 males and 2 females, giving a prevalence of 10.2% ($n=6/59$) for males and 3.6% ($n=2/56$) for females (Table 2).

Multivariate analysis of variables associated with the frequency of urogenital schistosomiasis among study participants at Esuekyir M/A School

Table 4 analyses the different binary variables and their possible association with urogenital schistosomiasis. Males (17.7%) had a higher percentage of urogenital schistosomiasis cases than females (12.9%). Of the positive participants, 94.3% were from students who were aware of schistosomiasis and its prevention methods,

Table 1 General characteristics of the study population ($n = 246$)

Variables	Males n(%)	Females n(%)
Gender	130(52.8%),	116(47.2%)
Age group		
4–7 years	15(11.5%)	14(12.1%)
8–11 years	52(40%)	41(35.3%)
12–15 years	54(41.5%)	52(44.8%)
16–19 years	9(6.9%)	9(7.8%)
Class group		
Kindergarten (KG)	18(13.8)	15(12.9)
Primary	78(60.0)	62(53.5)
Junior High School (JHS)	34(26.2)	39(33.6)
Knowledge about Schistosomiasis		
Yes	112(98.2)	93(93.9)
No	2(1.8)	6(6.1)
Swimming		
Yes	93(81.6)	56(56.6)
No	21(18.4)	43(43.4)
Bathing		
Yes	45(39.5)	26(26.3)
No	69(60.5)	73(73.7)
Washing		
Yes	2(1.8)	6(6.1)
No	112(98.2)	93(93.9)
Previous treatment		
Yes	37(32.5)	14(14.1)
No	77(67.5)	85(85.9)
No response	16(48.5)	17(51.5)

while 22.9% were from students who had previously received treatment for the disease. Variables relating to bathing and swimming made up 40.0% and 77.1% of the positive cases respectively. About 9.1% of the positive samples did not respond to the questionnaires. However, none of the variables showed any statistical significance, indicating a direct risk of urogenital schistosomiasis (p-value below 0.05).

Multivariate analysis of variables associated with the frequency of intestinal schistosomiasis among study participants at Esuekyir M/A School

Table 5 analyses the different binary variables and their possible association with intestinal schistosomiasis. Males (10.2%) had a higher percentage of positives compared to females (3.6%). All participants who tested positive to intestinal schistosomiasis stated they had knowledge of schistosomiasis and its preventative measures. Only one person who had previously been treated for schistosomiasis tested positive for intestinal schistosomiasis. Variables relating to bathing and swimming made up 37.5% and 62.5% of the positive cases respectively. However, none of the variables showed any statistical significance, indicating no direct risk of intestinal schistosomiasis (p-values above 0.05).

Table 2 Gender-based urogenital and intestinal schistosomiasis prevalence

Variables	Total n(%)	Males n(%)	Females n(%)
Number of urine samples	246	130(52.8)	116(47.2)
Urogenital schistosomiasis positives	38(15.5)	23(17.7)	15(12.9)
Number of stool samples	115	59(51.3)	56(48.7)
Intestinal schistosomiasis positives	8(7.0)	6(10.2)	2(3.6)

Table 3 Prevalence of urogenital schistosomiasis stratified by demographic data ($N = 246$)

Variables	Positives n(%)	Negative n(%)	X^2	*P*-value
Age group				
4–7 years	5(13.2)	24(11.5)	1.309	0.727
8–11 years	17(44.7)	76(36.5)		
12–15 years	14(36.8)	92(44.2)		
16–19 years	2(5.3)	16(7.7)		
Class group				
KG	5(13.2)	28(13.4)	6.356	0.042
Primary	28(73.7)	112(53.8)		
JHS	5(13.1)	68(32.7)		
No response	3(7.9)	30(14.42)		

Co-infection of *S. haematobium* and *S. mansoni*

Among the 115 school children who presented both stool and urine samples, only one (1) male subject, 13 years of age, tested positive for both *S. haematobium* and *S. mansoni*.

Discussion

The prevalence is crucial for effective control and prevention efforts. Urogenital and intestinal schistosomiasis may result in anaemia, stunted growth in children and infertility. Chronic forms have the propensity of leading to colon cancer for intestinal schistosomiasis and in the case of urogenital schistosomiasis, cervical cancer and bladder related cancers and female genital schistosomiasis (FGS) in females.

In the current study, there is an overall prevalence of urogenital schistosomiasis of 15.5% while that for intestinal schistosomiasis is 7.0%. Of the 246 urine samples taken from the study population, 130 were from males

Table 4 Multivariate analysis of variables associated with the frequency of urogenital schistosomiasis among study participants at Esuekyir M/A School

Variables	Positives n(%)	Negative n(%)	Constant	Cox snell R^2	CI(95%)	Sig(p)
Gender						
Male	23(17.7)	107(82.3)	-1.907	0.004	0.714—2.929	0.304
Female	15(12.9)	101(87.1)				
Knowledge on Schistosomiasis (heard of its causative agent or its preventative measures)						
Yes	33(94.3)	172(96.6)	-1.651	0.007	0.15–1.808	.305
No	2(5.7)	6(3.4)				
Previous treatment						
Yes	8(22.9)	43(24.2)	-1.682	0.005	0.132–2.194	.387
No	27(77.1)	135(75.8)				
Swimming						
Yes	27(77.1)	122(68.5)	-1.508	0.1	0.128–1.59	0.216
No	8(22.8)	56(31.5)				
Bathing						
Yes	14(40.0)	57(32.0)	-1.751	0.004	0.671–2.984	0.362
No	21(60.0)	121(68.0)				
No response	3(7.9)	30(14.42)				

Table 5 Multivariate analysis of variables associated with the frequency of intestinal schistosomiasis among study participants at Esuekyir M/A School

Variable	Positives n(%)	Negative n(%)	constant	Cox snell R^2	CI(95%)	Sig(p)
Gender						
Male	6(10.2)	53(89.8)	-3.277	0.016	0.569 -15.249	0.198
Female	2(3.6)	54(96.4)				
Knowledge on Schistosomiasis (heard of its causative agent or its preventative measures)						
Yes	8(100.0)	101(96.2)	-2.536	0.008	0.000- 0.000	0.999
No	0(0.0)	4(3.8)				
Previous treatment						
Yes	1(12.5)	23(21.9)	-3.135	0.006	0.230–16.784	0.538
No	7(87.5)	82(78.1)				
Swimming						
Yes	5(62.5)	75(71.4)	-2.695	0.004	0.322—6.365	0.637
No	3(37.5)	30(28.6)				
Bathing						
Yes	3(37.5)	32(30.5)	-2.681	0.001	0.308 – 6.076	0.680
No	5(62.5)	73(69.5)				
No response	0(0)	2(1.9)				

and 116 were from females. The prevalence within the two genders after screening were 17.7% for males and 12.9% for females. One hundred and fifteen (115) stool samples were also screened for intestinal schistosomiasis. After screening, the prevalence amongst males was 10.2% and females was 3.6%.

The result for urogenital schistosomiasis (95% CI from 10.94%—19.96%) is similar to reported prevalence of 10.2% in Akyemansa district in the Eastern region of Ghana [1] as well as 17.0% in Putubiw within the Abura-Asebu-Kwamankese district in the Central Region of Ghana [9]. These similar trends in prevalence across the different districts in Ghana highlight the need for consistent, targeted, and sustainable interventions. This suggests that the mass drug administration (MDA) has to be complemented with substantive water and sanitary facility improvements to combat schistosomiasis.

Table 6 Prevalence of intestinal schistosomiasis stratified by demographic data ($N=115$)

Variables	Positives n(%)	Negative n(%)	X^2	*P*-value
Age group				
4–7 years	0(0.0)	5(4.7)	1.129	0.77
8–11 years	5(62.5)	49(45.8)		
12–15 years	3(37.5)	51(47.7)		
16–19 years	0(0.0)	2(1.9)		
Class group				
KG	0(0.0)	1(0.9)	1.117	0.572
Primary	7(87.5)	75(70.1)		
JHS	1(12.5)	31(29.0)		
No response	0(0.0)	2(1.9)		

On the other hand, the prevalence of intestinal schistosomiasis is also lower than reports from Tanzania (68.3%) [26] and Tomefa in southern Ghana (55.6%) [7] but higher than prevalence reported from Asutsuare (2.0%) in Ghana [17]. The disparity in the aforementioned prevalence can be attributed to variations in the study durations, time for sample collection, participant demographics, and geographical locations**.** From Table 6, it becomes evident that none of the demographic factors exhibit a statistically significant association with intestinal *Schistosoma* infections. This conclusion is supported by the fact that, within a 95% confidence interval, none of the demographic variables yielded a significant *p*-value below 0.05.

An ANOVA analysis of the data taken, where students were put in class groups gave a *p*-value of 0.042 showing there was some significant difference amongst the class groupings with respect to urogenital schistosomiasis. Based on the data, primary school children had a higher prevalence of urogenital schistosomiasis compared to those in KG and JHS. This could be attributed to the fact that members of this class group make up a majority of the student population coupled with their frequent engagement in outdoor activities near the water body with less supervision. They are also mainly responsible for fetching water and assisting in washing and other household chores which increases their contact with contaminated water.

The prevalence of both urogenital and intestinal schistosomiasis observed in this study were comparable to a report from South-West Nigeria which gave 19% and 9% for urogenital and intestinal schistosomiasis respectively [27]. The relatively low prevalence of intestinal schistosomiasis in this study (7.0%) compared to that from Tomefa (55.6%) [7] could be attributed to the high sensitivity of the real-time PCR method used in their study.

Unfortunately for urogenital schistosomiasis, swimmers and other inhabitants who generally visit the river tend to urinate directly into it thereby releasing *S. haematobium* eggs. It is also important to note that, the presence of the different snail hosts, specific to parasite miracidia may vary during different seasons [20] and hence determine the distribution and frequency of the type of schistosomiasis which are present.

The prevalence of both intestinal and urogenital schistosomiasis was observed to be higher in males than in females, as a result of frequent visitation of males to the water body for swimming. This could be inferred from reports made in other regions in Ghana [2, 6, 25] and attributed to the socio-cultural practices in rural African settings, where female children stay home and assist in household chores while male children are left to roam. The higher prevalence of schistosomiasis in males could be attributed to their greater tendency to be truant compared to females. Additionally, there is a greater tendency for infected individuals to visit the water bodies, perpetuating continuous transmission and negatively impacting their academic performance. This truancy is often a result of the physical pain caused by the infection and the fear of stigmatization from their peers.

Based on our results, 22.9% of participants who had previously received treatment for schistosomiasis tested positive for urogenital schistosomiasis. In addition, 12.5% of positive cases for intestinal schistosomiasis responded “yes” for previous treatment for schistosomiasis. This indicates that mass drug administration alone is not sufficient for the long-term elimination of schistosomiasis [13].

Also, school children from age groups 8 – 11 and 12 – 15 years showed the highest prevalence, similar to reports in Ghana [8], Cote d’ Ivoire [15] and in Nigeria [30]. The contribution of age to the risk of schistosomiasis may not act independently. Instead, it might be interconnected with other factors influencing childcare, such as parental economic & social status and educational level [28]. This is because the likelihood of children engaging in activities like idling, playing in water sources, or wading through water for farming could be dependent on parental supervision, which in itself is influenced by economic status. In essence, age alone may not be the sole determinant, rather, it interacts with broader socio-economic factors influencing childcare. Consistent community engagement sessions should be done to educate people on the risks and effects of schistosomiasis as well as providing improved alternate sources of water at multiple vantage points and putting strict restrictions on the use of the river.

It was hypothesized that children in constant contact with the water body may have a higher risk of contracting either form of schistosomiasis [5, 21]. However, there was no significant association between contact with water bodies and cases of schistosomiasis. There was also one (1) case of co-infection of *S. haematobium* and *S. mansoni* found in a 13 year old, primary 4 male student.

Conclusion

The study provided some insights into the prevalence, impact, and implications of schistosomiasis on the health and educational well-being of the school-aged population in Esuekyir. It is evident that school-aged children in this area are vulnerable to both urogenital and intestinal schistosomiasis. If undetected and left untreated, during the early stages, these infections could have the potential to progress into chronic and severe forms of schistosomiasis. Therefore, there is the urgent need for multifaceted interventions, such as consistent public education, snail control, provision of safe water, sanitation alongside effective mass drug administration, to reduce the health and educational impact of the disease. Future studies should focus on longitudinal studies, community-based interventions, and assessing the effectiveness of control measures to significantly reduce the prevalence and consequences of schistosomiasis in Ghana.

Abbreviations

CDC	Centers for Disease Control
FGS	Female Genital Schistosomiasis
JHS	Junior High School
KG	Kindergarten
MDA	Mass Drug Administration
NTD	Neglected Tropical Diseases
SPSS	Statistical Package for the Social Sciences

Supplementary Information

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Supplementary Material 1.

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Authors' contributions

GGK and ASA developed the idea. DOK, BS, EAS, PKS, AAF, PAM, MA, EAN, BBB and ASA performed the experiments. DOK, EAN and PKS analyzed the data. DOK, BS and ASA, wrote the manuscript. DOK, ASA and GGK edited the manuscript. All authors read and approved the final version of the manuscript.

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Availability of data and materials

The datasets generated and/or analyzed during the current study will be made available by the corresponding author on reasonable request, in accordance with the relevant data sharing policies of Springer Nature (BMC Infectious Diseases).

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Cape Coast Teaching Hospital Ethical Review Committee (CCTHERC) with reference number CCTHERC/EC/2021/013 for data acquisition. All methods were carried out in accordance with relevant guidelines and regulations. Informed consent was obtained from appropriate authorities and participants before the study began. For participants under 18, signed written informed consent was secured from parents and guardians through teachers the day before sampling, after explaining the tests and questionnaire. Confidentiality and anonymity of participant information were maintained, with access restricted to the principal investigator and research assistants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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