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Urinary Schistosomiasis and Its Related Anaemia among Children in a High Risk Community in Ghana

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Authors' contributions

This work was carried out in collaboration between all authors. Authors IAB, ESD and LG designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ESD, IAB and PAK managed the analyses of the study. Authors RHA, USM and EO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Background: Urinary schistosomiasis is a disease of great public health importance and remains an important cause of morbidity and mortality among children globally. The disease, which is often characterized by painful urination and haematuria is common among children living in communities near dams. In this study, urinary schistosomiasis and its related anaemia among children in a community near the Weija dam in Accra, Ghana was investigated.
Methodology: We conducted a cross-sectional survey among 100 children of age range 4-12 years living in the Weija community of Ghana. Urine and blood samples were collected from the

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study participants for laboratory analyses. Urine samples were tested for haematuria, proteinuria and the *S. haematobium* ova. Full blood counts of anticoagulated blood samples were estimated by Sysmex 2000i-XE haematology analyzer to determine anaemia in children. Demographic and clinical data of the study participants were obtained by use of a structured questionnaire.

Results: The 100 children who participated in the study had a mean age of 12.12± 1.8 years, and comprised of 62 males and 38 females. More than half of the study participants (76%) tested positive for urinary schistosomiasis. Infection was significantly associated with sex (p=0.007) and age (p<0.001). Out of those infected, 68.4% were anaemic and a significant relationship was observed between infection and anaemia (p= 0.046). Most of the children (95%) had ever visited water contact sites for swimming, washing or fetching water for domestic use.

Conclusion: Our study shows a high prevalence of urinary schistosomiasis infection and its association with anaemia among the studied subjects in the Weija community. Mass drug administration for treatment, aggressive health education, regular screening and other relevant interventions are urgently needed in this community.

Keywords: Schistosomiasis; haematuria, anaemia; children; Weija; dam; Ghana.

1. INTRODUCTION

Schistosomiasis, also known as bilharzia or bilharziasis is caused by a parasitic trematode worm of genus *Schistosoma*, an infection which could lead to chronic ill health [1]. There are now 76 countries in which the disease is endemic, with more than 600 million people at risk of infection and some 200 million infected [2,3]. It is widely distributed in Africa, Caribean Islands, Latin America, the Eastern Mediterranean, South East Asia, and parts of the Western Pacific region. Human schistosomiasis is caused by six main species: *Schistosoma mansoni, S. japonicum, S. mekonji, S. intercalatum, S. haematobium* and *S. matheei,* but *S. haematobium* causes urinary schistosomiasis. The other species all cause intestinal schistosomiasis in human. The pathology in schistosomiasis is mainly due to the immunological and histological reaction of the host's tissues to parasite eggs retained in them. There is also marked eosinophilia and often hepatomegaly or splenomegaly. Other histopathological features of urinary schistosomiasis are bladder ulcers and polyposis and there is also a link with bladder cancer.

Schistosomiasis is particularly associated with water development projects such as dams and irrigation schemes [4,5]. In Egypt and the Sudan, where large irrigation systems have existed for many years, schistosomiasis ranks as a public health problem of the first order [6,7]. The disease has high prevalence (47%) in selected communities around the Gusau dam site in Zamfara state of Nigeria [5] and several other communities established near dams in Nigeria with prevalence ranging between 40-68% [8,9]. Similar reports have been made in Senegal where the disease affects 14.3-92.8% of children in Niakhur region of Fatick [10].

Generally, transmission of schistosomiasis among children living in communities near dams is influenced by several factors including gender, age, and activities that generally increase the frequency of contact with water sites such as swimming and wading in water [11,12]. Whilst infection in boys is reported to be higher than girls in some communities [10,13], there is no variation among gender or age in some other areas [14]. Of much concern however, is the relationship between heavy infection in children and impaired growth, psychological development and performance at school [15].

In Ghana, schistosomiasis is endemic with high prevalence among inhabitants of the local communities at the lower reaches of the Volta river, and also in the Eastern region. Reports on previous studies suggest that the disease is common in majority of the geographical regions of the country. A survey in the Awutu-Efutu Senya irrigation community in the Central region of Ghana revealed a prevalence of 11.2% among infants [16]. A study among some students in Cape Coast, also in the Central region of Ghana reported a prevalence of 34.4%. In communities near the Tono Irrigation Scheme at northern Ghana, both urinary and intestinal schistosomiasis were identified among school children [17]. Recent studies in the Ashanti region of Ghana show that schistosomiasis is not limited to rural areas of Ghana but also found in urban and peri-urban populations [13]. In the study, infection was reported to be higher among males (66.4%) than females (33.6 %), and risk

factors identified included economic, agricultural and recreational activities of the people in communities at the banks of a river. In some villages around Volta Lake, also in Ghana, over 90% of the children were infected by the disease [18], and Aryeetey et al. [19] observed that prevalence in some communities drained by the Densu River was high. Urinary schistosomiasis is more prevalent in individuals who bathe in fresh water bodies infested with the cercariae larvae of the *Schistosoma*, and in many areas, a high proportion of children between the ages of 10 and 14 are infected [20]. Human behavioral activities, which increase frequency of contact with water sites of an infested water body, especially fishing, fetching of water, swimming and washing are potential risk factors in transmission of the disease [21,22]. Painful or difficult urination (dysuria), blood in urine (haematuria), and eosinophilia are all important clinical signs of urinary schistosomiasis that could be used for prompt diagnosis and treatment in communities [14,23].

In Ghana, identification of communities affected by schistosomiasis and subsequent application of some intervention methods has been on-going for several decades. Despite these efforts the disease continues to affect children in several communities, and very little known about *S. haematobium* infection and its relation to anaemia. Our study focuses on children in one of the communities situated close to the Weija dam in Accra. We report on the current status of the disease and investigation of anaemia and other related clinical conditions suspected to result from *S. haematobium* infection.

2. MATERIALS AND METHODS

2.1 Study Area

Weija lake located 17km of Accra is situated on Latitude 5°30', Longitude 0° 20' W of the Gulf of Guinea [24]. The lake was created by construction of a dam on River Densu, and the reservoir lies within 0° 20' N and 5° 45 N. The lake covers approximately 3361.5 hectares of land at maximum water level, with an estimated storage capacity of 116.04 X $10^6 m^3$ [25], and shoreline of 48 km. The reservoir provides water to western Accra, supports an irrigation facility and is also an important fishery. Climatic conditions are tropical with temperatures averaging 27°C. Rainfall at this area is moderate and seasonal averaging 800 mm annually. The rainfall has its peak in June, with dry periods during December through March. The riparian populations are mostly peasant farmers, freshwater fishermen and traders. There are several water contact sites for the villages or communities where activities such as swimming, bathing, washing, docking of canoes, trading, and domestic water collection take place.

2.2 Study Design and Population

The study which was cross sectional was carried out at Mahem and Galilea, two communities near the Weija dam, both with a typical rural setting. It was conducted between the periods of April 2013 to July 2013. The study subjects totaling 100, were apparently healthy children of both sexes within the ages of 4 to 15 years residing in the selected communities. Study participants were selected by random sampling. Prior to the start of study, the consent of participants to partake in the study was sought, after the purpose of the study was explained to them. Those who were not prepared to fully partake were excluded. Additionally, appropriate parasitological investigations were conducted to exclude children with malaria and hookworm infections, as well as those on medications. A structured questionnaire was used to collect demographic, clinical information and history of contact with water body from the study participants. Fresh urine (10 ml) samples were collected from each participant between the hours of 10:00 am and 2:00 pm for analysis. The choice of period was based upon previous literature which states that, the number of ova in urine varies throughout the day, being highest in urine obtained between 10:00 am and 2:00 pm [26]. A venous blood sample of 2mls was also collected from each participant for analysis. All the samples collected were analysed at the Central Laboratory of Korle Bu Teaching Hospital in Accra.

2.3 Ethical Issues

The study was approved by the Ethics and Protocol Review Committee of the University of Ghana School of Biomedical and Allied Health Sciences.

2.4 Laboratory Analysis

2.4.1 Urine samples

Urine samples were examined macroscopically for appearance, and for the presence of blood. Biochemical tests were performed using a ten-

parameter urine chemistry strip (Combi 9) for diagnosing haematuria and proteinuria. Centrifugation and sedimentation techniques were employed to process the samples for microscopy [26]. Briefly, 10 ml urine was taken from the deposit of each specimen bottle after allowing to sediment for about I hour. The urine was centrifuged for 5 min at 3000 rpm and the supernatant discarded. The deposit was thereafter prepared on a slide and examined microscopically using X10 and X40 objectives for the characteristics of *S. haematobium* ova. In a very bloody sample 2 drops of Saponin solution were added to lyse the red cells to make it easier for detection of the parasite ova. Intensity of infection was categorized into three classes: light-intensity infection (egg count <50/10 ml urine), moderate-intensity infection (egg count 50-499/10 ml), and high-intensity infection (≥ 500 eggs/10 ml urine) based on previous specifications [26,27].

2.4.2 Blood samples

Sysmex® 2000i-XE Haematology analyzer was used to determine the full blood count of 2ml venous blood samples collected from each child using sterile single-use syringes into a sterile EDTA bottle. Children were considered anaemic if their haemoglobin levels were less than 11.5 g/dl (Normal Hb range for the children was 11.5-15.0 g/dl) [28].

2.5 Data Analysis

Data obtained from the study were entered into MS Excel and analysed with the Statistical Package for the Social Science version 11 (SPSS Inc). Descriptive analysis was carried out on the study variables and prevalence was reported as percentages. Significant association among the study variables were evaluated by Chi-square, T-test, Analysis of Variance and Pearson correlation analysis; *p* values of <0.05 were considered statistically significant.

3. RESULTS

3.1 Prevalence of Schistosomiasis

The 100 children who participated in the study had a mean age of 12.12± 1.8 years, and comprised of 62 males and 38 females. The overall prevalence of urinary schistosomiasis was 76.0%. The intensity of infection among the children was in various degrees ranging from light to moderate infections; in all, 28.0% (28/100) of the children had light infection and 48.0% (48/100) had moderate infection, with no heavy infection recorded (Table 1). Table 2 shows the prevalence and intensity (mean number of eggs/10 ml) of infection in relation to age and sex of the school children. Among the females, 60.5% (23/38) were infected with *S. haematobium* among whom 73.9% (n=17) were moderately infected. Similarly, 85.5% (53/62) of the male children were infected, among which 84.9% (45/53) were moderate infections. Overall, significant difference was observed between males and females in infection prevalence (p=0.0074) and intensity of infection (p= 0.0038). A striking observation in this study was that in each of all the representing age groups in the study, at least a child was infected. Highest infection, 87.5% (14/16) occurred among the age group 10-11 years, whilst the age, 4-5 years recorded the least infection rate of 25% (1/4). Significant differences were observed among infection prevalence of the different age groups (p<0.001) and a negative correlation was observed between infection intensity and age (r= -0.8). There was no significant difference in infection prevalence (p=0.633) between the two study sites namely, Mahem and Galilea, where prevalence were 78.3% (47/60) and 72.5% (29/40) respectively (not shown in table).

Table 1. Description of level of infection of urinary schistosomiasis among the school children

Intensity of urinary schistosomiasis	Frequency	Percentage (%)
Light infection	28	28
Moderate infection	48	48
Heavy infection	0	0
No infection	24	24
Total	100	100

3.2 Urinary Schistosomiasis and Associated Clinical Conditions

The various clinical characteristics investigated in this study including haematuria, proteinuria, anaemia and eosinophiluria are shown in Table 3. Screening of the 100 participants indicates that 29% and 56% of them had proteinuria and haematuria respectively; also 29% had both conditions of proteinuria and haematuria. An anaemic state was considered if the Hb level fell below 11.5 g/dl [28]. The mean Hb levels for

female and male participants were 9.8± 1.0 g/dl and 10.8±1.1 g/dl respectively. An appreciably high proportion of the children presented with anaemic condition (62%) and haematuria (56%), and some children were also identified to have dual clinical characteristics (Table 3). Dual clinical condition of anaemia and haematuria was common in the study, with 38 cases (38%) reported among the study population and 31 (40.8%) among infected children. Another remarkable observation made was the condition of eosinophilia (58.0%) among children with urinary schistosomiasis. Other clinical signs included painful urination (68%), most of which had persisted for almost a year without medical treatment. Only a minority (22%) of the parents sent their children to the hospital for treatment, upon complaints of their children of any symptoms of the disease.

As shown by Table 3, prevalence of anaemia among the infected children was 68.4% (52/76). Significant difference was observed in infection prevalence between children with anaemia and those without anaemia (p=0.046) (Table 4). However, there was no significant difference in the intensity of infection between anaemic and non-anaemic children (p=0.800) (Table 4).

3.3 Socio-demographic Information of Parents and Guardians

From our interview of parents and guardians of children who participated in the study, we observed that 56 % of them had good knowledge of urinary schistosomiasis. This is with regards to knowledge of how the disease is caused and the common symptoms. In terms of occupation, 74% of the parents were farmers, 19% petty traders, and 7% were unemployed. Concerning their educational background, a higher percentage (83%), were educated though not to a very high academic level; 50% had junior high school education, 33% had primary school education and 17% were illiterates.

Table 2. Prevalence and intensity (mean number of eggs/10 ml) of infection in relation to age and sex of the school children

Age (years)	No. examined	No. infected	Intensity (mean eggs/10 ml)
4-5	4	1(25.0)	17.0
6-7	5	4(80.0)	45.0
8-9	7	5(71.4)	62.0
10-11	16	14(87.5)	70.5
12-13	42	30(71.4)	55.5
14-15	26	22(84.6)	50.5
Total	100	76(76.0)	50.1
Sex			
Male	62	53(85.5)	59.0
Female	38	23(60.5)	41.5
Total	100	76(76.0)	50.1

Overall, significant difference was observed between males and females in infection prevalence (p=0.007) and intensity of infection (p= 0.004). Significant difference was observed in infection prevalence among different age groups (p<0.001). Negative correlation was observed between infection intensity and age (r= -0.8)

Table 3. Clinical characteristics associated with children screened for urinary schistosomiasis

All children screened (overall), n= 100		
Clinical condition	**No. affected**	**Percentage infection (%)**
Haematuria	56	56
Proteinuria	29	29
Anaemia	62	62
Haematuria + proteinuria	29	29
Haematuria + anaemia	38	38
Proteinuria + anaemia	18	18
Children with urinary schistosomiasis, n= 76		
Clinical condition	**No. affected**	**Percentage infection (%)**
Haematuria	56	73.6
Anaemia	52	68.4
Anaemia + haematuria	31	40.8

Table 4. Prevalence of anaemia in study participants

Urinary schistosomiasis	Haemoglobin level (g/dl)		Total
	Anaemia	No anaemia	
Light infection	20 (71.4%)	8 (28.6%)	28 (100%)
Moderate infection	32 (66.7%)	16 (33.3%)	48 (100%)
Heavy infection	0(0)	0(0)	0(0)
No infection	11 (45.8%)	13 (54.2%)	24 (100%)
Total	63	37	100

Significant difference was observed in infection prevalence between children with anaemia and those without anaemia (p=0.046). No significant relationship between intensity of infection and anaemia (p=0.800)

3.4 Frequency of Contact with Water Sites

The entire community depends on water from two main sources namely, pipe-borne and the Densu River for domestic use. Upon our investigations with parents and guardians of children involved in the study, we gathered that 58% (58/100) depended on both water sources, 23% (23/100) on pipe-borne water alone and 19% used only river water. None of the parents treated the water collected from the Densu River before use. The children visited the contact sites of river for purposes of bathing, washing, and fetching water for domestic purposes. Majority of the children, 95% (95/100) indicated that they never had contact with the Densu River.

4. DISCUSSION

Urinary schistosomiasis has been known in Ghana for decades now, following the construction of the first dam in the country, the Akosombo dam on river Volta in 1964 [29,12]. The disease is now common in several communities along the Volta lake [30,12]. The Weija dam was constructed in 1979 to supply pipe-borne water to parts of Accra and to support farming through irrigation. A report from a survey conducted between 1991 to 1992 indicated that urinary schistosomiasis had become endemic in the area, with prevalence rate of 25- 89.4% [31]. This was largely attributed to the presence of schistosome snail vectors, which had established themselves on the banks of the lake. Recently, an overall prevalence of 52% was recorded in Mahem and Galilea communities of Weija [11]. In our study we focused on the two communities with earlier reports of the disease. We recorded a higher prevalence (76%) of schistosomiasis, which suggests that the disease continues to be of public health importance with an increased prevalence in those communities. With such an increase in prevalence of the disease in the area according to our observation, it is clear that some intervention measures are urgently needed from health authorities in the country. Throughout the world, communities close to dams have suffered from high prevalence of the disease [5-10]. We suggest that such communities be given some special attention including constant monitoring, regular screening and treatment of the inhabitants for infection.

We recorded higher rates of infection among males than females, which is in agreement with reports elsewhere [10]. However, it is worth stating that contrary observations in which differences in distribution of infections between different sexes is not significant have also been reported [8,9]. The general tradition of the Ghanaian home is that, the girls remain home to partake in household chores whilst their male counterparts are allowed to go out of the house to play. This restriction on movement of girls could have prevented or reduced frequency of their contact with the water body, which presumably serves as source of infection.

In terms of age, 10-11 year group had the highest infection prevalence whilst the lowest occurred among children of age 4-5 years. The proximity of the two communities (Mahem and Galilea) to the water body allows the children to go and swim frequently which they regard as the main recreation in the area. From our observation, older children engage in this activity more than the younger ones, which appear to reflect in the observations, made in the study. Apart from children 4-5 years, all the other age groups recorded high prevalence of infection. This is in agreement with reports made by Sam-Wobo et al. [8] who studied the disease among children near the Oyan dam in Abeokuta, Nigeria. The inverse correlation between infection and age in this study is rather difficult to explain and requires further investigation.

Proteinuria, haematuria and eosinophiluria, often associated with schistosomiasis have in some cases been regarded as important markers for diagnosing the disease [32,6,33,34]. In this

study, it was not our focus to compare such clinical presentations with detection of *S. haematobium* ova to determine their suitability as markers for diagnosis. However, we observed that only haematuria and anaemia were present in infected children. Haematuria represented the highest clinical symptom among the children, which was in agreement with observations among Senegalese school children in the district of Niakhar, region of Fatick [10].

Of prime concern in this study were the haemoglobin levels of infected children. In keeping with other studies, we observed significantly higher infection prevalence among children with anaemia than those without anaemia [35,36]. This could impact negatively on cognitive function of children infected with schistosomiasis and consequently affect their academic performance at school. Generally, there are four possible mechanisms of schistosomiasis-associated anaemia, and they include iron deficiency anaemia, splenic erythrocyte retention, autoimmune haemolysis, and anaemia of inflammation [35-37].

Unfortunately, only a minority of parents would send their children to the clinic for treatment upon complaints of the child of any of the clinical symptoms of the disease. There is need for education in these communities to change the attitude of parents in this regard. Appropriate medications can completely clear schistosomiasis infections, and early treatment will not only prevent consequent complications but also reduce rate of contamination of water body by infected individuals.

Majority of the parents had good knowledge of schistosomiasis with regards to symptoms and mode of infection. This is probably as a result of the good educational levels of parents sampled in the study. Although the inhabitants had access to pipe borne water, a larger percentage depended on both pipe borne and the Densu river for water. It therefore appears that the provision of pipe borne water in this community has not changed the attitude of the people from visiting the water contact sites of the river for water. As long as this attitude remains there will be need for intensified control measures such as regular application of molluscides to kill the snail vectors. High water contact with dam water by residents of communities near dams predisposes them to continuous infection with schistosomiasis [23]. Most importantly, success in reduction of prevalence of the disease will demand an integrated approach involving mass treatment with drugs, public health education and effective vector control. In South Africa, Johnson & Appleton [4] observed that the provision of water to communities suffering from schistosomiasis alone could not effectively reduce prevalence of the disease. They recommended an integrated approach involving reduction of morbidity through treatment, vector control, in addition to provision of water.

5. CONCLUSION

Prevalence of schistosomiasis at Mahem and Galilea, two communities near the Weija dam is high with recorded high rates of haematuria and anaemia. Children of age 10-11years appear to be most affected which could be as a result of their frequent visit to water contact sites to swim. This study has revealed that children in these communities sited near the Weija dam need regular screening and treatment of schistosomiasis, as well as intensified public health education.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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