

Full Length Research Paper

River Wiwi: A source of *Schistosoma haematobium* infection in school children in Kumasi, an urban African setting

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In Ghana and many other sub-Saharan African countries, schistosomiasis is usually endemic in rural poor communities and whenever it is detected among urban settlers, it is usually attributed to prior visits by such patients to endemic rural areas. In this study, the prevalence of *Schistosoma haematobium* infection among basic school children in two African urban settings along River Wiwi in Kumasi, Ghana and the potential of this river as a source of the infection were verified. A total of 200 school children selected from two schools located on river Wiwi (Weweso Metropolitan Assembly and Ayigya Zongo Basic schools) were examined for urinary schistosomiasis after they were interviewed to determine the level of their knowledge of the disease. A 9% prevalent rate of urinary schistosomiasis was recorded among the school children with those of 13 to 15 years-age groups recording the highest prevalence (61.1%) of the infection. About 44% of the school children considered dysuria and haematuria to be normal and did not attribute it to entering infected water. Snails sampled from River Wiwi included *Bulinus* species of which 81.8% were found shedding *Schistosoma cercariae*. The river was also observed to provide suitable conditions for the growth and proliferation of these fresh water snail intermediate hosts of Schistosomes. This study has therefore established River Wiwi as a potential source of *S. haematobium* infection in Kumasi, an urban African setting.

Key words: Urban African setting, River Wiwi, Kumasi, schistosomiasis.

INTRODUCTION

Among human parasitic diseases, *Schistosoma* infection is the most prevalent after *Plasmodium* in terms of socio-economic and public health importance. According to the WHO (2012), schistosomiasis transmission has been documented in 77 countries and at least 230 million people require treatment every year, of which 90% are estimated to be in Africa. Humans become infected when infective cercariae released from the intermediate snail hosts (*Bulinus* species) penetrates the skin. Once inside

a person, the cercariae migrate through the blood stream to the liver where they develop into adults. *Schistosoma haematobium* adults migrate and live in the veins around the urinary bladder; whereas *Schistosoma mansoni* resides in veins around the intestines. Eggs laid by the females are passed out in urine (*S. haematobium*) and faeces (*S. mansoni*) and upon contact with water bodies, the eggs hatch into miracidia which then enter fresh water snail hosts where further development into the

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infective cercariae occurs (Cheesebrough, 2005; WHO, 2012). Children are the most affected in many of the endemic regions; many children are affected by the time they reach 10 years of age (Uneke et al., 2007). Schistosomiasis, in children, can cause anaemia, stunting growth and a reduced ability to learn (WHO, 2012). Urinary schistosomiasis is a chronic disease usually characterized by haematuria (Cheesebrough, 2005; Parija, 2006).

Fibrosis of the bladder and ureter, and kidney damage are common findings in advanced cases. Bladder cancer is also a possible late-stage complication (Elsebai, 1977; Cheever, 1978; Bedwani et al., 1998; Botelho et al., 2011). In women, the disease may be present with genital lesions, postcoital bleeding, pelvic pain and nodules in the vulva (Goldsmith et al., 1993; Mbabazi et al., 2011). Urogenital schistosomiasis is also considered to be a risk factor for HIV infection, especially in women (Feldmeier et al., 1995; Kjetland et al., 2005). Pathology of the seminal vesicles, prostate and other organs can also be induced (in men) as well as other irreversible health conditions such as infertility (WHO, 2012). Chronic schistosomiasis may affect people's ability to work and in some cases can result in death (Chippaux et al., 2000). At least 200,000 deaths relating to schistosomiasis occur annually in sub-Saharan Africa (WHO, 2012). These are significant health and economic burdens and therefore makes this neglected tropical disease an important public health problem to nations in the region.

Ghana is known to be one of the endemic countries of schistosomiasis in West Africa since 1895 [Annual Report on the Colony of Gold Coast (now Ghana), 1895] with the parasite commonly found in most of the inland water bodies as well as the Volta Lake and the various man-made dams in the country (Odei, 1965; Klump and Webbe, 1987). In 2001, prevalence of this infection in the country ranged between 54.8 and 60.0%, an indication that the disease is still a major problem in many communities (Nsawah-Nuamah et al., 2001). The Wiwi River, a typical example of an inland water body in Kumasi in the Ashanti Region of Ghana, takes its source from mountains near Aboabo Nkwanta and flows for about 13 miles southwest towards Abirem and Weweso. It passes through the Kwame Nkrumah University of Science and Technology campus to join River Sisai near Ahinsan. River Wiwi lies at Latitude 6° 48' N of the equator and Longitude 1° 32' E from the Meridian from its source and joins River Sisai at Latitude 6° 49' N of Equator and Longitude 1° 35' East of the Meridian. This river serves various purposes including recreational and agricultural activities and a source of household water, in the several communities it passed through along its course (Figure 1).

Klu (1973) observed that River Sisai which joins River Wiwi at Ahinsan, Kumasi, was infested with *Bulinus* species (the snail intermediate hosts of schistosomiasis) and that some children who were reported to have had

regular contacts with the river had the infection. River Boku, a tributary of River Wiwi was also found to be infested with the snail intermediate host and hence a possible source of the infection (Yeboah, 1981). In a routine medical laboratory examination, *S. haematobium* eggs were identified in the urine specimen of a 15 year old boy resident at 'Top-High', a residential community near Ayigya, an urban-poor community in Kumasi, Ghana. Further interrogation of this patient revealed that, he entered River Wiwi to pull out his brother from the river to prevent him from swimming. This brought about the need for this study to establish or otherwise, River Wiwi as source of *S. haematobium* infection in Kumasi, an Urban African Setting since the disease is usually considered endemic in rural areas. It is hoped that the results of this study will enable the design and implementation of the appropriate strategies for the prevention and control of the disease in Kumasi.

MATERIALS AND METHODS

Ethical approval and consent statement

Ethical approval for the study was obtained from the Human Research, Publications and Ethics Committee of the School of Medical Sciences, KNUST, Kumasi. Permission to conduct the study in the schools was granted by the head teachers of the schools (Weweso Metropolitan and Ayigya Zongo Basic Schools) and written consents from parents (Parent-teacher Associations) were also obtained.

Study population

A group of 200 school children between the ages of 10 to 20 years old from these two schools were randomly selected. Both schools are of walking distances from the river.

Behavioural pattern of children with regard to River Wiwi

A questionnaire was administered to the 200 school children to ascertain their activities in relation to River Wiwi as well as how their behavioural patterns affect the transmission of urinary schistosomiasis.

Urine sample collection

Urine samples of the 200 children interviewed were collected between 10:00 am and 2:00 pm (the period during which there is maximum egg excretion in urine) and examined within 10 h of collection.

Examination of urine samples

The urine filtration method for detecting presence of *S. haematobium* ova (WHO, 1993) was employed in this study. With the help of a syringe, 10 ml of the urine sample was passed through the nucleopore polycarbonate membrane filter (of pore size 12 µm) in the filtration unit. The filter was then removed from the unit, placed on a slide and examined microscopically for the presence of

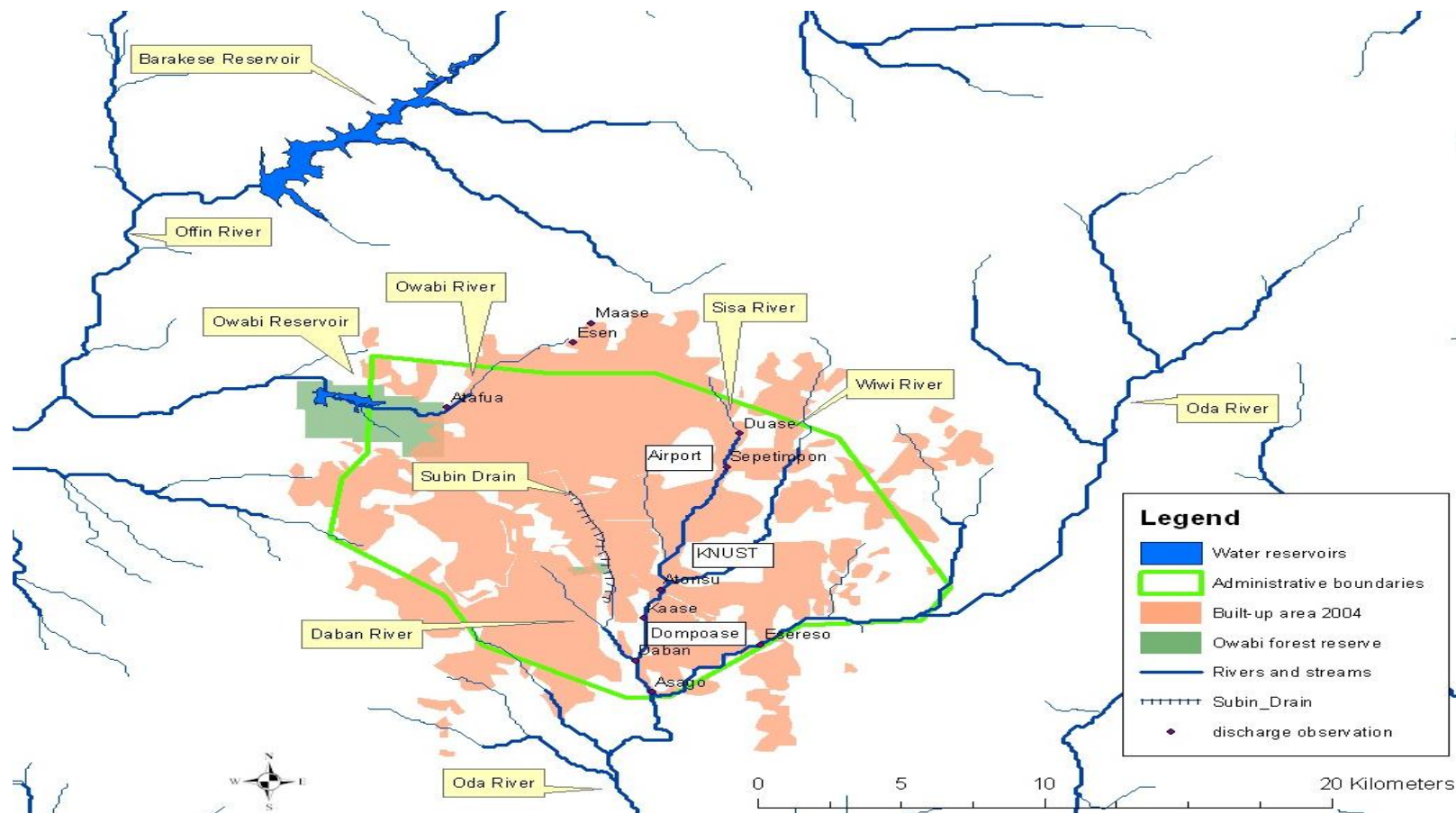


Figure 1. River Wiwi and some other streams that drain the Kumasi Metropolis (Department of Geography, KNUST Kumasi, Ghana).

the ova. Infection load was recorded as the number of eggs per 10 ml of urine.

Snail sampling and observation for *Schistosoma cercariae* shedding

Two sites of about 1 km apart on River Wiwi on KNUST

campus were selected (based on human-water-contact activity) for the fresh-water snails sampling. By means of a standard wire mesh scoop with a mesh size of 2 mm (Ouma et al., 1989) materials were scooped from the river. Snails were then recovered from the scooped debris into wide-mouth 1 L bottles half-filled with the river-water and taken to the Parasitology Laboratory of the School of Medical Sciences where based on their morphological

appearances they were sorted into species in accordance with Thompson (2004), Kristensen (1987) and Mandahl-Barth (1965, 1962). Ten snails from each group were placed individually in 50 ml glass beakers containing 25 ml of clear, filtered river water at room temperature ($24 \pm 1.0^\circ\text{C}$). The snails were exposed to artificial light for about 4 h and observed for cercariae shedding.

Snails that did not shed cercariae were re-exposed on

Table 1. Summary of interview Information and urinalysis results.

Background information	Number	Percentage
Pupils resident in Weweso	14	7
Pupils who go into River Wiwi	153	76.5
Pupils with Streams in their area of residence	16	8
Pupils' knowledge about Dysuria		
Pupils reporting dysuria	83	41.5
Pupils with dysuria and ova in urine ($n_o = 18$)	8	44.4
Pupils who think dysuria is normal	46	23
Pupils' knowledge about Haematuria		
Pupils reporting haematuria	29	14.5
Pupils with haematuria who have ova in urine ($n_o = 18$)	4	22.2
Pupils who think haematuria is normal	20	10
Pupils who do not know that haematuria could be due to contact with River Wiwi	23	11.5

Key: n_o = number of pupils who tested positive for over in urine.

the second day. Hand lens was used for the observation of the schistosome cercariae being shed.

RESULTS

A total of 200 urine samples were collected from the pupils for examination after each of them were interviewed to determine their level of knowledge on *S. haematobium* infection. Complains of dysuria were recorded from 83 of the pupils while 29 indicated experiencing haematuria (Table 1). By the urine examination results, 18 were confirmed of actually having the disease (Table 2). The 13 to 15 years age group were the most infected. Apart from wading through flooded bridges, most of the children come into contact with the river for recreational activities including swimming (Figure 2). At the two sites studied (S_1 and S_2), three different species of fresh-water snails were recovered (Figure 3) and identified as shown in Table 3. A total of 9 out of 11 *Bulinus* species collected shed schistosome cercariae within 48 h of collection (Table 3).

DISCUSSION

For any water body to be a potential source of urinary schistosomiasis, the disease must be prevalent in the exposed population and the intermediate snail hosts of the parasite, *S. haematobium* must be present in the water body. In this present study, 9% prevalence of schistosomiasis among 200 basic school children from two neighbouring schools located along the banks of River Wiwi; Weweso M/A and Ayigya Zongo Basic Schools, (Kumasi) was determined. From the administered questionnaire, these infected children have

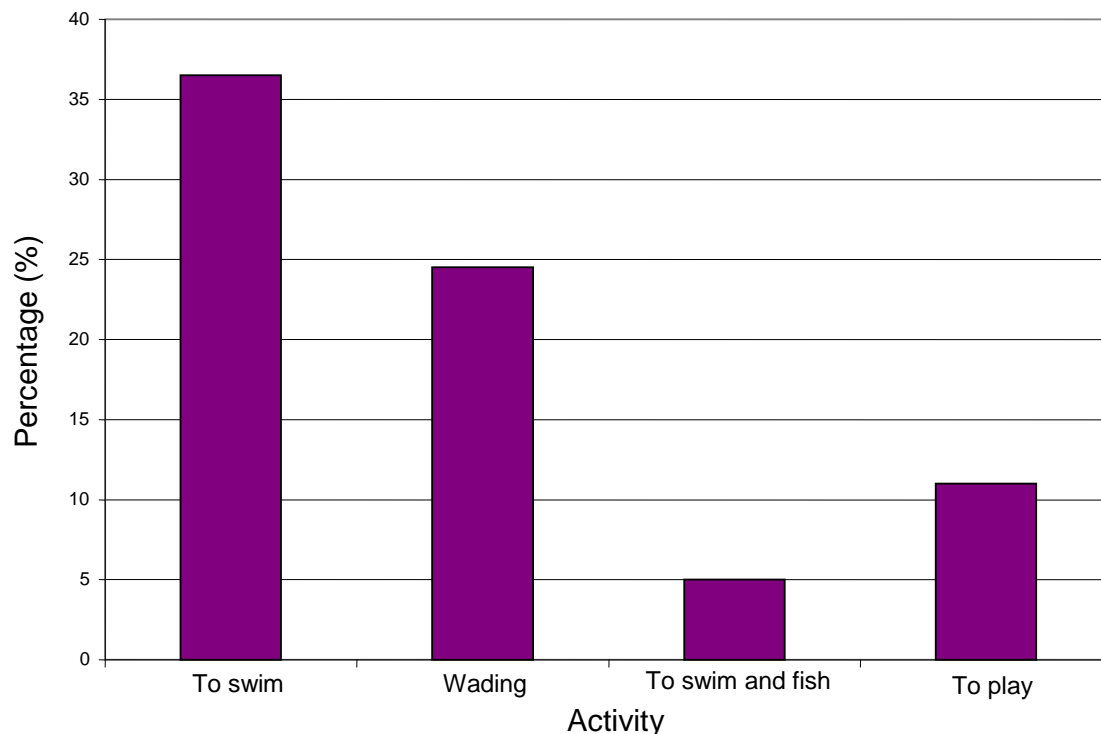
not travelled to any rural schistosomiasis endemic area and hence the only possible source of their infection was within the Kumasi metropolis. Our finding is similar to those reported by Ernould et al. (2000) in Niamey (Niger) among children in schools along the banks of the River Niger. In some urban centre school children in Nigeria, Chidozie and Daniyan (2008) recorded 12.9% prevalence rate of the infection in Minna while Akinwale et al. (2011) had as high as 57% in Epe. These prevalence rates are far higher than our finding in Kumasi, Ghana. However, our results learnt support to those of Akuoku (1992) who reported 4.15% schistosomiasis prevalence among Weweso M/A Basic School children, as well as Ampofo-Yeboah (1994) who also showed that River Wiwi was infested with snail intermediate hosts of schistosomes and that the conditions in the river were favourable for the growth and proliferation of the snails. However, further studies are necessary to differentiate the schistosomes cercariae shed to the species level. This will help determine if there are non-*S. haematobium* cercariae which may be associated with infection of domestic livestock and possible transmission to humans (Kariuki et al., 2004).

A snail survey of River Wiwi showed the presence of *Physa waterlotti*, *Potadoma* and *Bulinus* species at the water contact sites studied. Only the *Bulinus* species were found to have shed cercariae of *S. haematobium* upon observation under laboratory conditions (Table 3). Although, the survey showed low levels of *Bulinus* species in the river, conditions in the river are rife for the growth and proliferation of these snail species: It is a slow flowing river (less than 20 cm per second), heavily silted and with pockets of ponds that hardly dry up even during the dry seasons. This probably contributes to the snail's survival in the river in addition to their inherent ability to

Table 2. Results of urine sample examination.

Age (years)	Infected females (n)	Infected males (n)	Total infected (n)	Total prevalence (%)
10-12	3 (17)	3 (25)	6 (42)	33.3
13-15	5 (56)	6 (76)	11 (132)	61.1
16-18	0 (12)	1 (13)	1 (25)	5.6
19-21	0 (0)	0 (1)	0 (1)	0
Total	8 (85)	10 (115)	18 (200)	100

Key: n = total number examined.

**Figure 2.** Activities of school children in River Wiwi.

estivate for over 6 months. Many water plants including water lilies (*Nymphaea* species) are also present and thus protect the snails from predators such as birds. Water lilies and the other horizontal vegetation present provide resting places and egg-laying surfaces on their undersides, areas probably very rich in oxygen due to photosynthesis, while decaying plant matter and microflora of the river provide abundant food for the snails.

In Ghana and many other sub-Saharan African countries, urinary schistosomiasis is known to be an infection of the rural folks (McCullough, 1965; Odei, 1965); hence, attention on the eradication of the disease is usually directed to the rural communities with very little concern for urban settings. Weweso and Ayigya Zongo are two neighbouring African urban settings in Kumasi,

the second largest city in Ghana. The residents of these two communities have access to pipe-borne water for drinking, washing and other domestic activities. For most residents therefore, the only water-contact period (Dolton and Pole, 1978) in the Wiwi River is the rainy seasons when the river floods its banks and they have to wade through the flooded wooden bridges to get across the bridges. In this study, about 25% of the school children examined had contact with the river in this way whilst the rest use the river for recreational activities (Figure 2). One possible ways of reducing the infection in this community is to reduce the population of the snail intermediate hosts (Schiff, 1979) by occasionally dredging the river which will reduce the amount of the water plants present as well as increase the water current to over 20 cm per second.

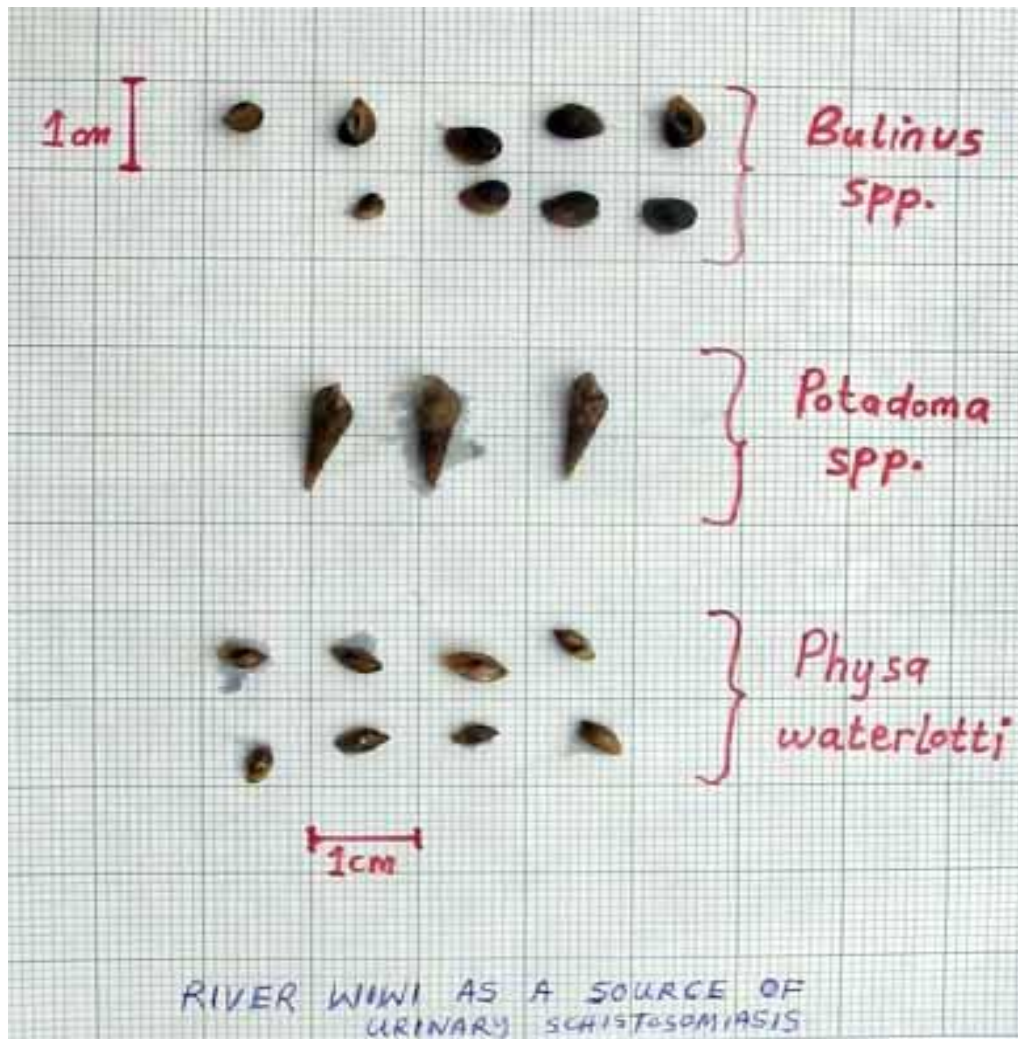


Figure 3. Some of the fresh-water snail species found in River Wiwi.

Table 3. Collection and observation of snails for Cercariae shedding.

Period	Snail species	No of snails			No. of snails shedding cercariae
		S ₁	S ₂	Total	
1 st Sampling	<i>Bulinus</i> species	4	2	6	4
	<i>Physa waterlotti</i>	5	2	7	0
	<i>Potadoma</i> species	0	3	3	0
2 nd Sampling	<i>Bulinus</i> species	3	2	5	5
	<i>Physa waterlotti</i>	6	3	9	0
	<i>Potadoma</i> species	1	1	2	0

Key: S₁ = snail sampling site 1; S₂ = snail sampling site 2.

Wading through flooded wooden bridges can also be prevented by building higher bridges over the river. The high schistosomiasis prevalence observed among the

boys of 10- to 15-year-old age groups was because they had the most frequent contact with the river and this agrees with the findings of Klump and Webbe (1987) in a

farming village on the Volta Lake. Although, 14% of the school children reported of having haematuria and 41.5% dysuria, only 4 out of the 18 infected children surprisingly had both haematuria and ova while 8 had both dysuria and ova in urine. These values are low and might probably have been due to improper collection of urine samples by the school children. The studied population indicated of having lived in/or around Weweso and Ayigya Zongo throughout their lives and the only contact they have had with a river, stream or dam therefore was River Wiwi. Hence, the *S. haematobium* infection observed certainly could not be traced to any other water body besides the Wiwi River. Majority of the school children had a fair knowledge of urinary schistosomiasis and its transmission patterns; about 89% knew that haematuria is as a result of entering infected water. Only 10% of the children considered it normal to experience haematuria while 23% also indicated dysuria as a normal occurrence.

The 18 children (out of 200) who were infected with the *S. haematobium* were treated with one day praziquantel dosage regimen (20 mg/kg body weight, bid) and 14 became urine negative for *S. haematobium* when urine quantitation for the ova was conducted five months after the treatment, giving a cure rate of 77.78% which is statistically comparable to the 94.4% cure rate reported by Oniya and Jeje (2010) after treatment with a higher dose of praziquantel (40 mg/kg body weight, bid). However, strategic public health education of the disease, in addition to mass chemotherapeutic drug treatment of all infected people is necessary in these communities and more especially in all the schools located in the catchment area of River Wiwi.

Conclusions

The results of this study have shown River Wiwi in Kumasi as a potential source of *S. haematobium* infection to school children in the Ayigya Zongo and Weweso communities of Kumasi in Ghana. As such, the African urban settings which are adequately provided with good household-water supply systems are still not left out of the urinary schistosomiasis menace. For a successful implementation of national control programmes therefore, the trends in the prevalence and intensity of schistosomiasis in urban settlements must also be monitored.

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