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Epidemiology and Burden of *Schistosoma Haematobium* Infection Among School Children in Osun State, Nigeria

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Abstract

Background: Urinary schistosomiasis is one of the most prevalent Neglected Tropical Diseases (NTDs) and remains a major public health problem among school-aged pupils in tropical and subtropical countries.

Objective: This study assessed the current status of the urinary schistosomiasis among school children in a rural community, Southwestern Nigeria.

Methods: A school-based cross-sectional study was conducted in a Nigerian rural community between October 2016 and March 2017. Urine specimens were collected from 300 school children, and were processed using sedimentation technique and examined microscopically for the ova of *Schistosoma haematobium*. Infected participants were treated with oral doses of praziquantel (PZQ) at 40 mg/Kg body weight. Egg reduction rate was used to assess the drug efficacy. Population abundance of the snail intermediate hosts was assessed using hand-held scooping. Cercaria shedding was assessed and species of snails identified based on shell morphology. Data was analysed with the SPSS version 18.0 software

Results: A prevalence of 73.3% (19.13 ± 29.13) of urinary schistosomiasis was recorded among the study participants. Male students (52.70%, 9.86 ± 18.33) were more infected than females (47.27%, 19.26 ± 29.13). Prevalence of infection decreases as the age increases with the highest prevalence among the age group 13 to 16 years (66.5%, 14.28 ± 26.40) and the lowest among the age group 17 to 21years (62.5%, 7.09 ± 8.13). The 220 *Schistosoma haematobium* infected children received a single oral dose of 40 mg / kg of PZQ and were followed for 12 weeks. At 4th, 8th and 12th weeks after treatment, the ERR was 65.70%, 82.91% and 100%, consecutively. ERR was significantly higher in children with mild infection compared to those with severe infection. Ninety-nine (90.5%) children were microscopically negative four weeks after treatment. After the second treatment cycle, the cure rate at 8th and 12th weeks was 98.60% and 100%

sequentially. Three different freshwater snails were obtained from the study area. Percentage distribution of the three snail hosts population is as follows: Bulinus spp (26.0%), *Biomphalaria spp*. (12.3%) and *Oncomelania spp* (61.7%). The highest cercariae shedding snail was the *Bulinus spp*.

Conclusion: The results revealed a high prevalence of urinary schistosomiasis among the school children with associated impacts on the packed cell volume. The therapeutic potency of PZQ at 40 mg/kg against *S. haematobium* was re-established.

Keywords: Children, Praziquantel, Packed cell volume

1. Introduction

Human Schistosomiasis is a chronic parasitic disease caused by trematode (genus *Schistosoma*), is second only to malaria as the most devastating parasitic disease [1]. It is a leading cause of morbidity and mortality in Africa, South America, and Asia [2]. It is estimated that more than 200 million people are infected with at least one species of *Schistosoma* globally. Currently, over 90% of the disease is found in the sub-Saharan Africa. Each year, there are over 200,000 deaths related to schistosomiasis [3].

The disease is endemic in seventy six countries in which 700 million people have been at risk of schistosomiasis. It is commonly found among people whose occupation and domestic tasks bring them in contact with infested water [4]. Species of freshwater snail belonging to the genus Bulinus are intermediate hosts of the fluke. The snail hosts breed in ponds, streams and irrigation channels contaminated by the urine of infected individuals [5]. *Schistosoma haematobium* infection transmission is hinging on the presence of cercaria-infested water and contact with the human population. Hence, schistosomiasis is characteristically focal in the distribution and widespread both in the rural and urban communities of developing countries [6].

Among the countries in sub-Saharan Africa, Nigeria is reported to have highest burden of schistosomiasis, with an estimated 29 million cases of infection [5]. It is widely spread mainly in riverine areas and communities around dams. This infection is a significant public health problem with about 101 million individuals at the risk of infection in the country [7]. Nigeria is known to be endemic for both urinary and intestinal schistosomiasis, *Schistosoma haematobium* infection is however more widespread. The prevalence of urinary schistosomiasis reported to be from 2.07 to 78.43 % in different parts of the country and it is high among school children [8]. Human infection with schistosomes depends on certain transmission requirements [9]. These comprise the presence of viable schistosome eggs in freshwater habitats containing snail intermediate hosts and human exposure to such habitats containing infective cercariae. Cercariae emerge daily from an infected snail intermediate host over several weeks. Light is the principal stimulus that causes cercarial shedding. In addition, water turbulence and chemicals found on the human skin influence cercarial activity [10].

In Nigeria, infection with *S. hematobium* has been reported in many parts of the country, with varying intensity and prevalence rates, and there is continuous rise in the incidence of the infection [11]. High prevalence of urinary schistosomiasis was observed in Ikorodu area of Lagos and in riverine communities of Sokoto, Nigeria [12, 13]. Similarly, a study carried out in year 2014 in the same region with this present study reported a prevalence of 61.5% [14]. However, the data collected is still grossly inadequate for effective control programme. In addition, there is persistent problem of re-infection which calls for regular epidemiological surveys and assessment of cercariae shedding pattern of the snail intermediate hosts. This study was therefore designed to determine the epidemiology and burden of *S. haematobium* infection among school children in Ore, Osun state of Nigeria. The presence of intermediate hosts and their cercariae shedding ability was also examined. It is hoped that the results generated will complement the existing baseline information on the epidemiology of this infection in the country.

2. Material and Method

Study area and Population: This cross sectional epidemiological study was conducted in Ore

secondary school, Ore village in Odo-Otin Local Government area in Osun state, Nigeria between October 2016 and March 2017. The area lies between Latitude 7044' and 7057' N and Longitude 4026' and 4041 East of the Greenwich Meridian. The community is in the rainforest belt of Nigeria, and farming is the main occupation. The climate is tropical with distinct dry (November to March) and rainy (April to October) seasons. The community has no reliable pipe-borne water supply but wells and big river which are frequently visited for domestic use as well as leisure and religious believes.

Study population and inclusion criteria: Pupils living in the study area were invited to participate in the study. Volunteers free from known chronic diseases other than possible helminth infections and living in the community for at least one year were recruited into the study. Children who had taken medication for schistosomiasis six months before the study and were in severe medical conditions were excluded.

Sample size determination: Fisher's formula was employed to determine the sample size [15]. It was calculated to give a 95% confidence level; a margin of error of +/-5%, using a prevalence of 21% in a survey of urinary schistosomiasis in Adim Community, Cross River State, Nigeria [16].The calculated minimum sample size was 254.8. However, 300 samples were collected for the study to accommodate possible attritions. A Random sampling technique was used to select the requisite 300 participants for the study.

Ethical Issue: Ethical clearance was obtained from the Ethical Committee of Ladoke Akintola University of Technology Teaching Hospital, Osogbo, Nigeria (LTH/EC/2015/12/252). The parasitological survey was preceded by a pre-survey contact during which permission was obtained from both the community leaders and the school teachers; they were briefed about the scope of the study before its commencement. Verbal consent was also sought from the parents of the participating pupils through the Parent Teacher Association of the school.

Sample Collection and Microscopical Examination of the Urine: The students were enlightened on how to collect terminal urine. Five to 10ml of urine samples were collected in well labelled, clean, wide mouthed containers with screw caps between 10:00am and 2:00pm to ensure maximum egg yield [17]. They were gently packed in a carton and sealed to prevent spillage during transportation to the laboratory. Urine samples collected were screened for visible hematuria, mixed and transferred into each labeled centrifuge tube and centrifuged for 5minutes to sediment the *schistosome* eggs. The supernatant fluid was discarded and a drop of sediment was transferred on a clean glass slide, covered with a cover glass. The preparation was examined microscopically using x10 objective with the condenser iris closed sufficiently to give good contrast. *Schistosome* eggs were counted and recorded as number of eggs/10 ml of urine [18]. Infection intensity was classified as light (<50 eggs/10 ml of urine) or heavy ($\geqslant$ 50 eggs/10 ml of urine), as defined by the World Health Organization [18]. Urine microscopy was repeated for those participants whose slides tested negative.

Determination of packed cell volume: Packed cell volume of the study participants were estimated using microhematocrit centrifuge. The centrifuge was spun for 5 minutes at 10,000g of speed. Packed cell volumes values $\leqslant$ 31% were considered as anaemic [19].

Treatment and follow-up: All the school children that provided urine samples in the pre-treatment study were included in the analysis of infection patterns at baseline, but only the children positive for *S. haematobium* eggs were treated with two single oral doses(40mg/kg) of praziquantel(PZQ), given with a four-week interval in-between. The drug was administered with a sachet of clean water following confirmation that the child ate at home or ate the food that was provided by the school. Cure rates (CR) and egg reduction rates (ERR) were assessed by taking urine samples on the fourth, eight and twelfth week.

Snail sampling: The snail sampling was done by two collectors using hand wire mesh scoop. If necessary, snails were collected by hand, and necessary precautions were observed. The number of snails collected were counted and recorded. The snails were identified in the laboratory using the procedures obtained from Danish Bilharziasis Laboratory, Denmark [20]. The shedding and crushing methods were employed to screen

schistosome intermediate host for cercariae. In the shedding method, snails in a glass bottle containing clean water were exposed to light for about four hours, matured cercariae were then liberated into the surrounding water. Cercariae were identified as described by Frandsen and Christensen, 1984[21, 22].

Statistical analysis: Version 18.0 of the statistical package for social sciences (SPSS) for windows software package was used for all the data analysis, comparisons of prevalence by subject age and gender was made using x^2 tests. Differences in mean egg counts between dichotomous variables and variables with more than two levels were explored using Student's t -tests and one-way analysis of variance (ANOVA), respectively.

3. Results

Prevalence and Intensity of urinary schistosomiasis: A total of 300 secondary school children were enrolled for this study, 134 (44.7%) of them were males while 166 (55.3%) were females. The age of the children ranged from 9 to 21years with a total mean of 13.85±2.35 (Table 1). Of the 220 infected students, 116 (86.6%) were males while 104(62.7%) were females (Table 2). The prevalence of *S. haematobium* infection was 73.3% (220/300), which increased with age, with the peak around 13 to 16 years (76.0%) (Table 3). This study showed that there was a statistical difference (p value=0.004) between the prevalence of urinary schistosomiasis and gender.

Impact of urinary schistosomiasis on PCV: This study showed that the students without urinary schistosomiasis had higher PCV (36.44 ± 3.57) than those with urinary schistosomiasis (35.64 ± 4.49) with p value <0.001. Of those with schistosoma infection, 107 (85.6%) male students had normal PCV while 9 (7.8%) of them had low PCV (p = 0.000) and 71 (55.9%) female students had normal PCV while 42 (19.1%) of them had low PCV. In contrary, only 6 (7.5%) female students had low PCV among those without urinary schistosomiasis with p = 0.341. It was observed that low PCV decreased with increase in age group with p = 0.001 as shown in Figure 1.

Cercariae shedding:A total of 405 freshwater snails were collected from the study site. Three species of snail were common at the study area. They were *Bulinus spp* (105), Biomphalaria spp. (50) and *Oncomelania spp* (250). The abundance of Oncomelania snails was high at the study area at the time of study compared to the other two snails. The most cercariae-shedding snails were *Bulinus spp*. with a daily production of 2 to 15 cercariae depending on the size.

Treatment and follow-up: Table 4 and Figure 2 show praziquantel treatment outcomes for a period of 12 weeks. Two hundred and twenty children were treated with a single oral dose of 40 mg/kg of PZQ. The overall ERR at four weeks, eight weeks and 12 weeks post treatment was 65.70%, 82.91% and 100% respectively. The cure rate at four weeks, eight weeks and twelve weeks was 90.5%, 98.6% and 100% respectively.

Table 1: General characteristics and distribution of *Schistosoma haematobium* among School Children in Osun State, Nigeria

Subject's characteristics	Number (%)
Number of subject studied	300
Male: Female	134 (44.7):166 (55.3)
Mean Age (years) ± SD	13.85 ± 2.35
No of students positive for *S. haematobium*	220 (73.3)
Mean Intensity ± SD	19.13 ± 29.13
Mean Packed Cell Volume (PCV) for *S. haematobium* positive individuals	35.64 ± 4.49
Mean PCV for *S. haematobium* negative individuals	36.44 ± 3.57

Table 2: Prevalence and intensity of *S. haematobium* among school children students by gender

Sex	No examined	*S.h* positive	Light infection	Heavy infection
Male	134	116 (86.6%)	9 (1.7%)	107(87.1%)
Female	166	104 (62.7%)	11 (2.9%)	93 (88.5%)
Total	300	220	20	200
p value		0.004	0.060	0.140

Note: Pearson Chi square test was used to assess the association between the intensity of infection and gender.

Table 3: Prevalence and intensity of *S. haematobium* among school children students by age group

Age group (Yr)	No examined	*S.h* positive	Light infection	Heavy infection
9-12	89	62 (69.7%)	3 (4.8%)	59 (95.2%)
13-16	179	136 (76.0%)	15 (11.02%)	121 (88.98%)
>16	32	22 (68.8%)	2 (9.1%)	20 (90.9%)
Total	300	220 (73.3%)	20 (1.7%)	200 (61.5%)
p value		0.450	0.087	0.132

Note: Chi square test was used to verify possible associations between the age group and infection intensity.

Table 4: Cure rates and intensity reduction rates over 12 weeks in 220 school children infected with *S.haematobium* after one treatment with praziquantel

Egg intensity (egg/5ml)	No of subjects (%)	4weeks after treatment			8weeks after treatment			12weeks after treatment		
		No. cured	Cure rate (%)	Egg reduction rate (%)	No. cured	Cure rate (%)	Egg reduction rate (%)	No. cured	Cure rate (%)	Egg Reduction rate (%)
<50	195(88.6)	187	95.9	40.83	195	100.0	100.0	195	100.0	100.0
≥50	25(11.4)	12	48.0	77.52	22	88.0	75.03	25	100.0	100.0
Total	220(100%)	199	90.5	65.70	217	98.6	82.91	220	100.0	100.0

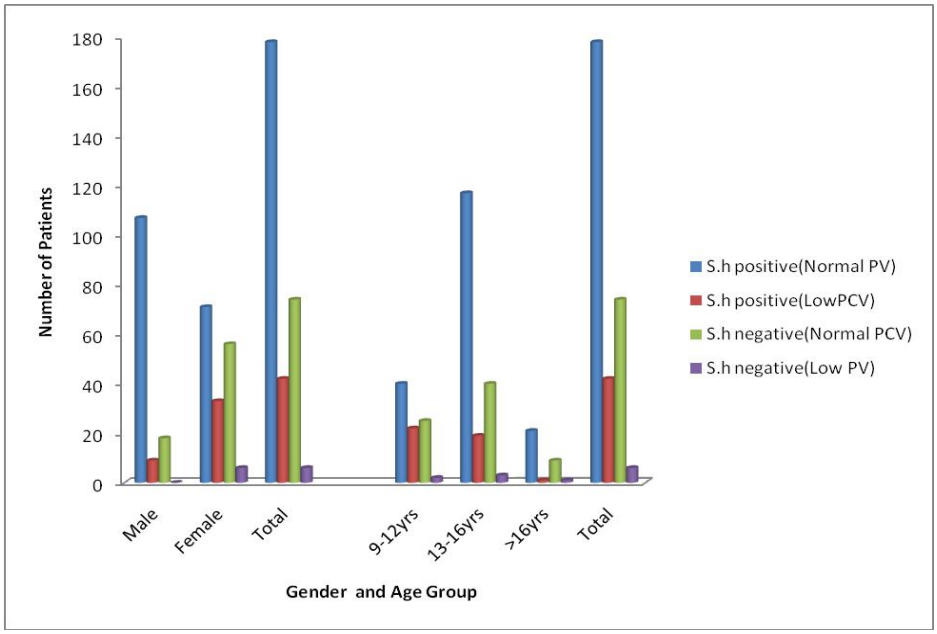

Figure 1: Impact of urinary schistosomiasis on PCV by gender and age group

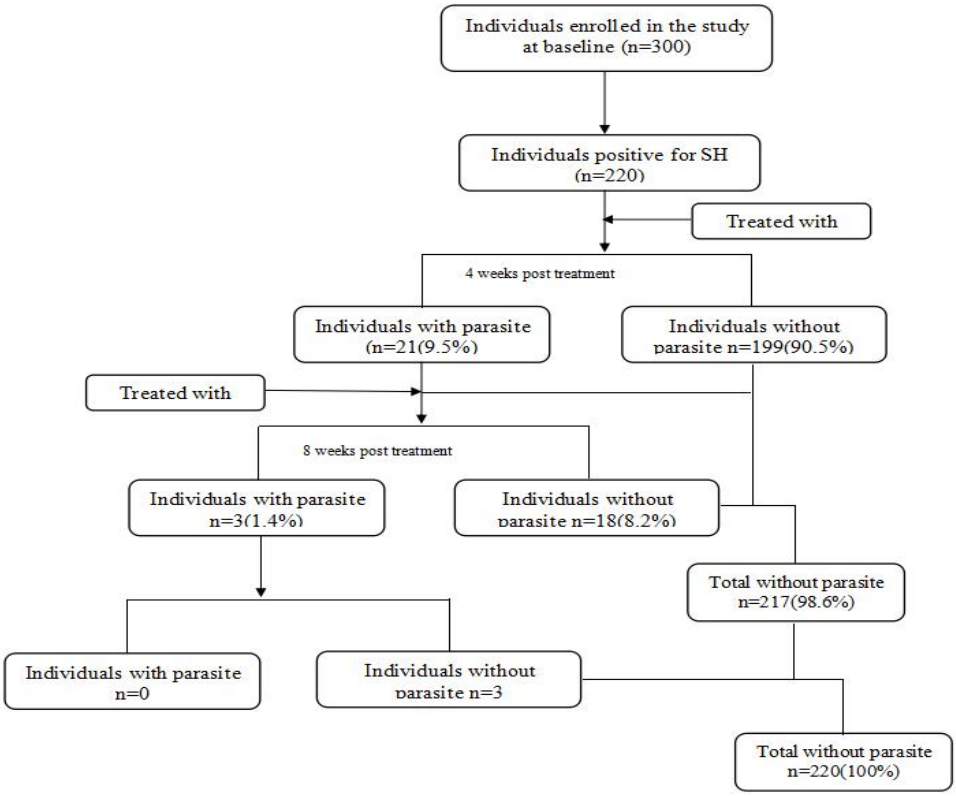

Figure 2: Study compliance for the efficacy of praziquantel to treat urinary schistosomiasis among school children

4. Discussion

The prevalence rate of 73.3% confirms that S. haematobium infection is prevalent in this rural part of Osun State. Many studies have been done on the prevalence of urinary schistosomiasis in different part of Nigeria. Recently, 9.5% overall prevalence of schistosomiasis was officially released by

Nigeria's Federal Ministry of Health [23]. Various reports across Nigeria have shown that schistosomiasis is a burden, varying prevalence ranging from 0.0% in Ukwelo-Obudu Community in Cross River State to 78.4% in Lagos State [24, 25]. Urinary schistosomiasis is a persistent health burden among school children in Nigerian rural communities. From this and previous studies, the results obtained observed that urinary schistosomiasis is particularly common in the southwest region of Nigeria. For instance, this study showed that there was an increasing trend of prevalence infection among children from 9 years to 16 years. This is in collaboration with previous studies done by Oladejo and Ofoezie [26] Mafiana et al [27]who reported that school children aged 5 to 15 years were more likely to be infected with S.haematobium [28, 29]. However, some studies reported a decline in infection from 14 years and above attributing the declining trend in prevalence of infection to probable age acquired immunity [30]. Male students (86.6%) were significantly more infected than female students (62.7%) in this study. This may be an indication that male students are more exposed to infection through water contacts and higher cercarial exposure [22]. Previous studies have also reported higher prevalence among male students than among their female counterparts [28, 31, 32]. Higher intensity of the infection was also observed among males students; this suggests that male students have a greater burden of worms than females. Similar results have been reported in previous studies [28, 33].

Visible haematuria (34.6%) was also recorded in this study and was an on the spot indication of the presence of urinary schistosomiasis in the study community. As observed, blood in urine (haematuria) has been shown to have significant positive correlation with presence and intensity of the infection because the quantity of blood passed out increased with intensity of infection [34, 35].The higher prevalence of S. haematobium infection using micro-hematuria and visible hematuria as diagnostic tools suggests the daily variation of *S. haematobium* egg excretion in infected individuals [35].

The students with urinary schistosomiasis had lower mean PCV than those without urinary schistosomiasis and the difference was statistically significant. This is expected as it has been generally reported in the previous studies that urinary schistosomiasis lower the PCV of infected individuals [36]. Despite this observation, 80.9% of those with urinary schistosomiasis had normal PCV values [19]. This may be as a result of good nutrition and availability of fresh green vegetables, fresh fruits and sea foods in the study community while the changes in the gender may be as a result of menstrual period among the female students.

In spite of relatively low cure rates observed in some areas, praziquantel has been the drug of choice for the treatment of all forms of schistosomiasis [19]. As noted in the report on therapeutic failures [37, 38], continuous monitoring of the efficacy of PZQ is important while awaiting the discovery and development of potent drugs. In this study, PZQ performance was considered satisfactory, with ERRs in the eighth and twelfth week being 82.91% and 100%, sequentially [39]. Our results also showed that there was a significant difference between cure rates and infection intensities, according to previous studies, which showed that cure rates were actively higher in subjects with mild infections before treatment than in those with moderate or heavy infections [40, 41]. Construction and operation of dams are the likely cause of high increase of *Bulinus* species, *Biomphalaria* species and *Oncomelania* species snail intermediate hosts in the study area. In this study, *Bulinus* spp exhibited highest number of cercariae-shedding patterns. However, *Oncomelania* spp which is the snail intermediate host of S. japonicum was the most populated snails at the study site as at the time of the study. This suggests the likelihood of *S. japonicum* infection in the study area. Elucidating snail abundance, snail infection and distribution of cercariae will have implications in devising cost-effective control interventions.

Limitation

Due to an undefined number of undetected cases, studies using different methods are necessary to provide further information on the extent of the infection. It is also advised that additional studies are conducted to investigate and control re-infection rates. The present study did not take data on

socioeconomic, behavioral or environmental factors for analysis.

Future recommendations

To prevent new cases and reinfection, and to achieve a long-term reduction or even elimination of schistosomiasis, public awareness must be raised. This could be integrated into the already existing mass distribution campaigns. There is need for school based health education program and provision of potable water, in order to reduce contact with cercarial infected waters.

Conclusion

The results obtained show that the rural communities in Osun State, Nigeria are endemic for urinary schistosomiasis. The high burden of the infection obtained in the present study is an indication that the urogenital schistosomiasis is still a serious health problem in certain regions of Nigeria. In the light of this, sound health education, periodic school-based de-worming programme, will bring about significant reductions in morbidity and mortality associated with *Schistosoma hematobium* infections among the school children.

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