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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 urinary schistosomiasis among school children in a rural community in Southwestern Nigeria.

Materials and Methods: A school-based cross-sectional study was conducted in Ore Community, Odo-Otin Local Government area in Osun state, Nigeria. 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. The egg reduction rate was used to assess the drug efficacy. The 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 were 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 the 8th and 12th weeks wasv98.60% and 100% sequentially. Three different freshwater snails were obtained from the study area. The 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 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: Schistosomiasis, Children, Praziquantel, Packed cell volume

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INTRODUCTION

Human Schistosomiasis is a chronic parasitic disease caused by trematode (genus Schistosoma), which is second only to malaria as the most devastating parasitic disease (Bushara et al., 2017). It is a leading cause of morbidity and mortality in Africa, South America, and Asia (Adenowo et al., 2015). 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 sub-Saharan Africa. Each year, there are over 200,000 deaths related to schistosomiasis (Ismail et al., 2014).
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 infected water (Birma et al., 2017). 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 (Houmsou et al., 2016). 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 (Grymes's et al., 2006).

Among the countries in sub-Saharan Africa, Nigeria is reported to have the highest burden of schistosomiasis, with an estimated 29 million cases of infection (Houmsou et al., 2016). 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 (Abdulkareem et al., 2018). 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 (Atalabi and Adubi, 2019). Human infection with schistosomes depends on certain transmission requirements (Meurs et al., 2013). 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 (Owojori et al., 2006).

In Nigeria, infection with S. haematobium has been reported in many parts of the country, with varying intensity and prevalence rates, and there is a continuous rise in the incidence of the infection (Onifade and Oniya, 2018). A high prevalence of urinary schistosomiasis was observed in the Ikorodu area of Lagos and in the riverine communities of Sokoto, Nigeria (Oluwasogo and Fagbemi, 2013; Singh and Muddasiru, 2014). Similarly, a study carried out in the year 2014 in the same region with this present study reported a prevalence of 61.5% (Hassan et al., 2014). However, the data collected is still grossly inadequate for an effective control programme. In addition, there is the 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.

MATERIALS AND METHODS

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

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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 rivers which are frequently visited for domestic use as well as leisure and religious beliefs.

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 (Machin et al., 2018). 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 (Inyang-Etoh et al., 2017). 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, Oshogbo, 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 10:00 am and 2:00 pm to ensure maximum egg yield (Onile et al., 2017). 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 labelled 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 a good contrast. Schistosome eggs were counted and recorded as the number of eggs/10 ml of urine (Obisike et al., 2019). Infection intensity was classified as light (<50 eggs/10 ml of urine) or heavy (≥50 eggs/10 ml of urine), as defined by the World Health Organization (Obisike et al., 2019). 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 a microhematocrit centrifuge. The centrifuge was spun for 5 minutes at 10,000g of speed. Packed cell volume values ≤ 31% were considered as anaemic (Ojurongbe et al., 2014).

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, eighth and twelfth-week Snail sampling: The snail sampling was done by two collectors using a hand wire mesh scoop. If necessary, snails were collected by hand, and necessary precautions were observed. The number of snails collected was counted and recorded. The snails were identified in the laboratory using the procedures obtained from Danish Bilharziasis Laboratory, Denmark (Brown and Kristensen, 1993). 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 (Frandsen and Christensen, 1984; Okeke and Ubachukwu, 2013).

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.

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 21 years with a total mean of 13.85±2.35 (Table 1).

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

Subject's characteristics	Number (%)
Number of subjects 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 PCV for S. haematobium positive individuals	35.64 ± 4.49
Mean PCV for S. haematobium negative individuals	36.44 ± 3.57

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 = 0.000. Of those with Schistosoma infection, 107 (85.6%) male students had normal PCV while 9 (7.8%) of them

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had low PCV (p = 0.000) and 71 (55.9%) female students had normal PCV while 42 (19.1%) of them had low PCV. On the contrary, only 6 (7.5%) female students had low PCV among those without urinary schistosomiasis with p = 0.341.

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	0.06	0.14

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
12-Sep	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		0.45	0.087	0.132

It was observed that low PCV decreased with an increase in the 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 in the study area. They were Bulinus spp (105), Biomphalaria spp. (50) and Oncomelania spp (250). The abundance of Oncomelania snails was high in 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.

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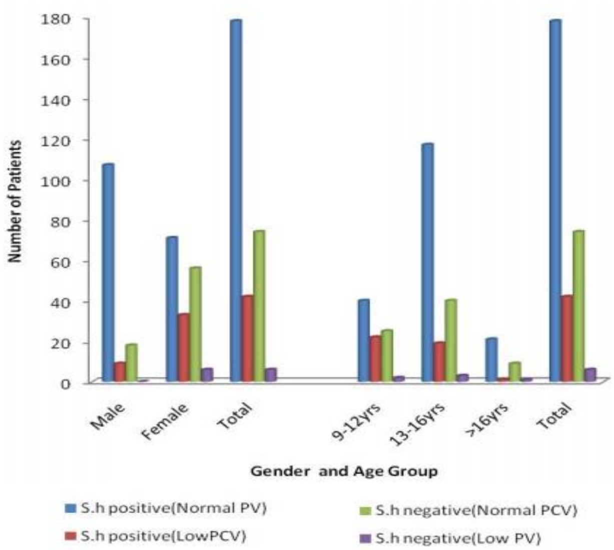

Figure 1: Impact of urinary schistosomiasis on PCV by gender and age group

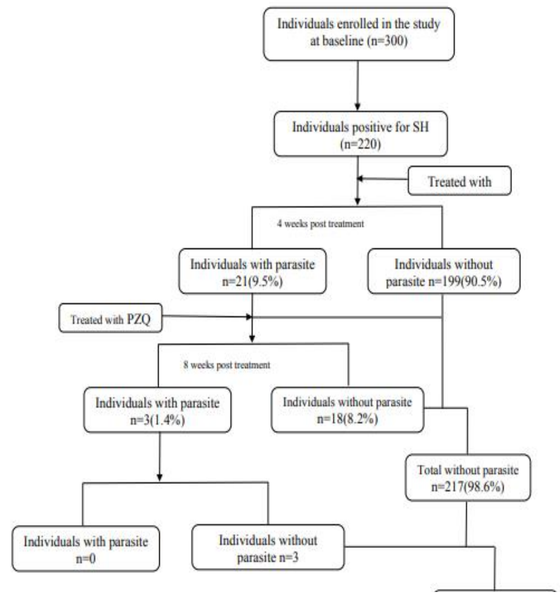

Figure 2: Study compliance for the efficacy of praziquantel to treat urinary schistosomiasis among the school children

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 parts of Nigeria. Recently, a 9.5% overall prevalence of schistosomiasis was officially released by Nigeria's Federal Ministry of Health (Bishop, 2017). Various reports across Nigeria have shown that schistosomiasis is a burden, varying prevalence ranging from 0.0% in Uwelo-Obudu Community in Cross River State to 78.4% in Lagos State (Ingang-Etoh et al., 2009; Oluwasogo and Fagbemi, 2013). Prevalence reports on schistosomiasis from different parts of Nigeria are presented in Table 5. 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 of infection among children from 9 years to 16 years. This is in collaboration with previous studies done by Oladejo and Oozy (2006) and Mafiana et al (2003) who reported that school children aged 5 to 15 years were more likely to be infected with S.haematobium (Ejima and Odaibo, 2010; Mohammed et al., 2015). However, some studies reported a decline in infection from 14 years and above attributing the declining trend in the prevalence of infection to probable age acquired immunity (Satayathum et al., 2006). 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 the infection through water contacts and higher cercarial

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Table 5: Prevalence Reports of Urinary Schistosomiasis among School Children in Nigeria

Study Location in Nigeria	Reported Prevalence of Urinary Schistosomiasis
Lere LG Area, Kaduna State	12.3% (Luka et al., 2015)
Ovia South west LGA Edo State	32.6% (Noriode et al., 2018)
Ozuitem, Abia State	42.3% (Alozie and Anosike, 2004)
Nkalagu, Ebonyi State	41.0% (Afiukwa et al., 2019)
Abuja, FCT	14.8% (Bassey and Ekpo, 2018)
Ukwelo-Obudu, Cross River State	0.0% (Ingang-Etoh et al., 2009)
Ilewo-Orile, Ogun State	58.1% (Ekpo et al., 2010)
Zaria, Kaduna State	10.5% (Bishop and Akoh, 2018)
Benue State	41.5% (Houmsou et al., 2012)
Abarma, Zamfara State	74.0% (Bala et al., 2012)
Ikorodu North LG Area, Lagos State	78.4% (Oluwasogo and Fagbemi, 2013)
Shelleng LG Area, Adamawa State	48.0% (Birma et al., 2017)
Peri-urban Communities, South–western Nigeria	51.1% (Ugbomoiko et al., 2010)
Oduma, Enugu State	13.6% (Aribodor et al., 2019)
Maiduguri, Borno State	62.0% (Yauba et al., 2018)
Kwara State	45.6% (Abdulkareem et al., 2018)
Dawakin Kudu, Kano State	10.6% (Duwa et al., 2019)
Saki, Oyo State	32.7% (Salawu et al., 2014)

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exposure (Okeke and Ubachukwu, 2013). Previous studies have also reported a higher prevalence among male students than among their female counterparts (Ejima and Odaibo, 2010; Ekpo et al., 2010; Masaku et al., 2015). Higher intensity of the infection was also observed among male students; this suggests that male students have a greater burden of worms than females. Similar results have been reported in previous studies (Ejima and Odaibo, 2010; Ariyo et al., 2004). 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 the urine (haematuria) has been shown to have a significant positive correlation with the presence and intensity of the infection because the quantity of blood passed out increased with the intensity of infection (Ugbomoiko et al., 2010; Houmsou et al., 2011). 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 (Houmsou et al., 2011).

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 lowers the PCV of infected individuals (Njaanake et al., 2015). Despite this observation, 80.9% of those with urinary schistosomiasis had normal PCV values (Ojurongbe et al., 2014). This may be as a result of good nutrition and availability of fresh green vegetables, fresh fruits and seafood in the study community while the changes in the gender may be as a result of the 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 (Ojurongbe et al., 2014). As noted in the report on therapeutic failures (Liang et al., 2000; Silva et al., 2005), 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 weeks being 82.91% and 100%, sequentially (WHO, 2013). 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 (Olds et al., 1999; King et al., 2011). Construction and operation of dams are the likely cause of the high increase of Bulinus species, Biomphalaria species and Oncomelania species snail intermediate hosts in the study area. In this study, Bulinus spp exhibited the highest number of cercariae- shedding patterns. However, Oncomelania spp which is the snail intermediate host of S. japonicum was the most populated snail at the study site 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 reinfection rates. The present study did not take data on socioeconomic, behavioural or environmental factors for analysis.

FUTURE RECOMMENDATIONS

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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 a need for school-based health education programs and the 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 urogenital schistosomiasis is still a serious health

problem in certain regions of Nigeria. In the light of this, sound health education, periodic school-based deworming programmes, will bring about significant reductions in morbidity and mortality associated with Schistosoma hematobium infections among the school children

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