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Prevalence of Urinary Schistosomiasis and Efficacy of Praziquantel; a Case Study of School Pupils in Oke-Igbo, Ondo State, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author MOO designed the study, author OEO wrote the first draft of the manuscript. Authors OEO and MOO managed the analyses of the study. Both authors read and approved the final manuscript.

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ABSTRACT

Schistosomiasis is one of the most prevalent Neglected Tropical Diseases (NTDs) and remains a major public health problem among school-aged pupils in developing countries. In this study, urine samples were collected along with basic demographic information from 528 pupils from 3 primary schools in Oke-Igbo community of Ondo state, Nigeria. Centrifugation technique was used in the analysis of urine samples for *Schistosoma haematobium.* Out of the 528 pupils, I05 (19.9%) were infected while 37(7.0%) showed visible haematuria. Positive cases were treated using Praziquantel (40 mg/kg body weight) and a rescreening was done for the treated pupils 3months post-treatment to assess the efficacy of Praziquantel at the standard dose. 7 (6.7%) pupils were still positive after rescreening, with haematuria cases in 4 (3.8%). Age group 6-10 years had the highest frequency in the 3 schools, which is suggestive that they engaged more in water-contact activities. Praziquantel administered in a single oral dose at 40 mg/kg body weight showed 93.3% parasitological cure rate

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with a Percentage Geomean Egg Count (GMEC) reduction of 77.72%. There was a significant difference in the prevalence rate between age groups and gender (P<0.05). Disease control in Ondo State, is basically centred on chemotherapy hence, the rate of re-infection following parasitological cure is still of major concern. There is need for more political commitment from the government to provide basic amenities such as toilet facilities, and pipe borne water to rural areas other than the usual chemotherapy if elimination is to be achieved.

Keywords: Schistosomiasis; praziquantel; efficacy; prevalence; haematuria; control.

1. INTRODUCTION

Schistosomiasis is one of the most prevalent neglected tropical diseases (NTDs) with significant public health importance [1]. According to Bruun and Aagaard [2], about 240 million people are infected with *Schistosoma* spp. and about 700 million people worldwide are at risk of infection. Among world population, about 239 million people were diagnosed with active *Schistosoma* infections in 2009 [3], 85% of which lived in sub-Saharan Africa, where approximately 112 million and 54 million were infected with urinary and intestinal schistosomiasis respectively. While the population at risk of *Schistosoma* infection is greater than 600 million [4], the disability-adjusted life years (DALYs) due to schistosomiasis is about 1.7-4.5 million. Africa accounts for 85% of the disease burden [5], as the population of people that die as a consequence of the disease per year ranges between 150,000 and 280,000.

Urinary schistosomiasis is widespread in both rural and urban communities of Nigeria, with prevalence ranging between 2% and 90%, with the vast majority of cases occurring among the poor and marginalized [6,7,8,9,10]. Individual perception of the aetiology and impact of urinary schistosomiasis differ by their levels of education and gender. The disease is characterized by haematuria as a classical sign. It is associated with bladder and urethral fibrosis, sandy patches in the bladder mucosa and hydronephrosis that are commonly seen in chronic cases while bladder cancer is possible as late-stage complication [5]. On the other hand, intestinal clinical manifestations include abdominal pain, diarrhoea, and blood in the stool. In advanced cases, hepatosplenomegaly is common and is repeatedly associated with ascites and other signs of portal hypertension [5,11].

Schistosoma haematobium infection had been found in many parts of the country with varying intensities, prevalence rates and incidence is believed to be on the increase [12]. The true epidemiological data appears difficult in developing nations, because of inadequate researches and no epidemiological control or information centre on tropical diseases despite its relevance in planning for control in any locality. In Ondo state, the disease is a public health problem where the prevalence rates in all 18 Local Governments Areas was between 41-95.7% [13].

The epidemiology of urinary schistosomiasis in Nigeria and other countries mostly target the schoolchildren while only a limited number of studies have been conducted at the community levels. Schistosomiasis primarily results from lack of education and public health facilities, appalling sanitary conditions and poverty found in many underdeveloped nations like Africa. Primary school children are particularly vulnerable to schistosomiasis because of their habit of playing in water, where they may contract the infection. As such, they are the ideal target group to investigate the prevalence of schistosomiasis and the data collected from this age group can be used to assess not only whether schistosomiasis threatens the health of schoolchildren, but can also be used as reference for evaluating the need for community intervention [14]. In addition, cognitive ability and physical fitness among these children have been greatly reduced and increased irregularities in school participation and attendance [9].

Currently, the antischistosomal drug of choice for the treatment of schistosomiasis is praziquantel (PZQ). It is the mainstay of the current strategy against schistosomiasis morbidity control and is highly effective against the five schistosome species that infect humans [15]. Praziquantel is a pyrazinoquinoline derivative and its safety and efficacy have ensured its widespread usage. It is recommended that school-aged children and high-risk groups of adults in communities with a prevalence of 10% to 50% use it once every two years. In communities where the prevalence is

above 50%, both children and adults are required to be treated once a year [16].

Praziquantel has been used widely successfully in many national control programmes. However, there is evidence of clinically relevant resistance developing [17]. The extensive use of PZQ and the problem of reduced therapeutic efficacy is on the increase globally, and this has led to the growing concern regarding the use of a single drug for the treatment of a disease affecting more than 200 million people [18]. Already countries such as Egypt [19], Zimbabwe and Cameroon [20] have reported low cure rates of PZQ. There is, therefore, a need for constant and continuous monitoring of Praziquantel being the widespread use drug. A critical aspect in the assessment of PZQ efficacy is the drug's activities during the different parasite development stages. Experimental laboratory studies have shown that activities of Praziquantel are stage dependent with the drug acting primarily against the adult worm stages, whereas immature schistosomes (two to four weeks old) are less susceptible. These observations then points to the need to develop another efficient drug, or combinations of drugs that will be potent against all stages of the parasite. Therefore, there is a need for continuous monitoring of the Praziquantel's efficacy in endemic areas while other drugs are being waited for.

The cardinal objective in the control of schistosomiasis is the reduction of morbidity and mortality to levels below public health significance. Over the years, emphasis has shifted from the non-realizable goal of eradication to the more realistic goal of morbidity control. In this context, Gemmel et al. [21], defined "a control programme" as the "implementation of specific measures by a disease control authority to limit the incidence of the disease". Such implementation may involve specific technical interventions and perhaps legislation to enforce compliance. The success of this type of approach is predicated on an accurate ecological diagnosis, that is, a diagnosis of the human community, its parasitological characteristics, its physical-geographical environmental attributes and man's behavioural attitudes and customs [22]. There is a consensus of opinion that the control of the disease should be integrated, since there is enormous morbidity associated with schistosomiasis which is ranked next to malaria in terms of public health importance. Therefore, there is significant emphasis on the need for a coordinated and sustainable means for the control of the disease [3].

2. MATERIALS AND METHODS

2.1 Study Area and Subjects

This study was carried out in Oke-Igbo Community in Ile-Oluji/Okeigbo Local Government, Ondo State, Nigeria. The village is about 250km away from Lagos bounded by river Oni, its geographical coordinates are 7^0 10′ N; 4^0 43′ E. It has an estimated population of 172, 870 at the 2006 census with an area of 698 square kilometres. There are over 10 schools, including primary and secondary, and the major occupation of the villagers is farming with cocoa and oil palm being the major cash crops. Despite the provision of boreholes, though insufficient, the villagers were observed to prefer the springs, streams and rivers for diverse purposes. Oke-Igbo has six springs namely Majeroku, Omi-Iye, Omi Iya-Isobo, Ogiran, Ojege-Amuye and Egbatedo as well as streams and rivers serving as different contact sites such as Odo-Oni, Odo-Oloori, Odo-Arepa, Odo-Alaidan, Odo-Awo. These also serve as major sources of water supply for domestic, occupational and recreational purposes such as drinking, bathing, washing, swimming (especially the younger ones), farming etc. Before commencement, approval was sought from the Ondo State Ministry of Health, Village Chieftains and Head of the three schools used for the survey.

2.2 Study Design

Three primary schools were surveyed namely: St. Joseph, St. Luke and St. Mark primary schools. Total population sampling was done and a total of five hundred and twenty-eight (528) pupils were sampled for the study; 300 (56.8%) male and 228 (43.2%) female. The ages of pupils examined ranged from 4 to 15 years. The subjects were then grouped into three age groups viz: age group 4–5, 6–10 and 11–15 years. The pupils were recruited from their classes using the class register with the help of the teachers though a few were absent from school at the time of the survey. Demographic data including the name, age, gender and weight of all participants were recorded. The pupils were screened for urinary schistosomiasis to determine the prevalence of infection.

2.3 Urinalysis

Urine samples were collected between 09:00 and 12:00h. Each pupil was given a clean, dry, screw-capped bottle to urinate in with an emphasis on the last drop. The urine collected was immediately transported in ice boxes to the biology research laboratory of Federal University of Technology Akure (FUTA) for analysis. Laboratory analysis of the urine was done using the centrifugation method [23]. 10 mls of urine was centrifuged at 1,500 rpm for 3 min and the residue examined under the X10 objective of the microscope for the presence of terminal spined ova of *S. haematobium*. Eggs of *S. haematobium* were counted under light microscope at low magnification. Results were expressed as the number of *S. haematobium* eggs/10mL urine. Cases of haematuria observed were also recorded.

3. RESULTS AND DISCUSSION

3.1 Prevalence of Infection in Examined Population before Treatment

A total of five hundred and twenty-eight (528) pupils were examined which, I05 (19.9%) were infected (Table 1) with 37(7.0%) showing visible haematuria. The age of the examined pupils ranged from 4 to 15 years. The overall prevalence rate in the three schools was 19.9% and the highest prevalence was recorded in St Luke primary school with 36.3% while St. Joseph primary school showed the lowest prevalence rate of 13.7%. The highest case of haematuria, 15(12.1%) was observed in St. Luke primary school.

Gender prevalence showed that 23.3% (n=70) of male and 15.4% (n=35) female pupils were infected (Table 3). The prevalence of infection by age before treatment showed that pupils in the age-group 6-10years had the highest frequency of infection while age 4-5 had the lowest frequency of infection (Fig. 1). Chi-square (χ^2) test showed that there was a significant relationship ($P<0.05$) between age group and prevalence of infection ($\chi^2=5.077$, Sig=0.079). It also revealed that there was a significant relationship ($P<0.05$) between gender and prevalence of infection ($\chi^2=5.181$, Sig=0.023).

3.2 Post Treatment Assessment

Three (3) months after treatment, a re-screening to assess the efficacy of the single dose praziquantel administered showed that 7 (6.7%)

Table 1. Overall prevalence of infection in the examined population

School	No examined	No positive (%)	Haematuria (%)
St. Joseph	271	37(13.7)	18(6.6)
St. Luke	124	45(36.3)	15(12.1)
St. Mark	133	23(17.3)	4(3.0)
Total	528	105(19.9)	37(7.0)

Table 2. Pre-treatment prevalence of urinary schistosomiasis in the pupils according to gender

School	Total no examined	No examined Male (%)	No positive Male (%)	No examined Female (%)	No positive Female (%)	Haematuria (%) Male	Female
St. Joseph	271	163 (60.1)	28 (17.2)	108 (39.9)	9 (8.3)	13(4.8)	5(1.8)
St. Luke	124	63 (50.8)	30 (47.6)	61 (49.2)	15 (24.6)	12(9.7)	3(2.4)
St. Mark	133	74 (55.6)	12 (16.2)	59 (44.4)	11 (18.6)	3(2.3)	1(0.8)
Total	528	300 (56.8)	70 (23.3)	228 (43.2)	35 (15.4)	32(6.1)	5(0)

Table 3. Assessment of the efficacy of praziquantel in treated pupils in Oke-Igbo

School	Total no examined	Male (%)	Female (%)	Positive (%)	Negative (%)
St. Joseph	37	28 (75.7)	9 (24.3)	3 (8.1)	34 (91.9)
St. Luke	45	30 (66.7)	15(53.3)	2 (4.4)	43 (95.6)
St. Mark	23	12 (52.2)	11 (47.8)	2 (8.7)	21 (91.3)
Total	105	70 (66.7)	35 (33.3)	7 (6.7)	98 (93.3)

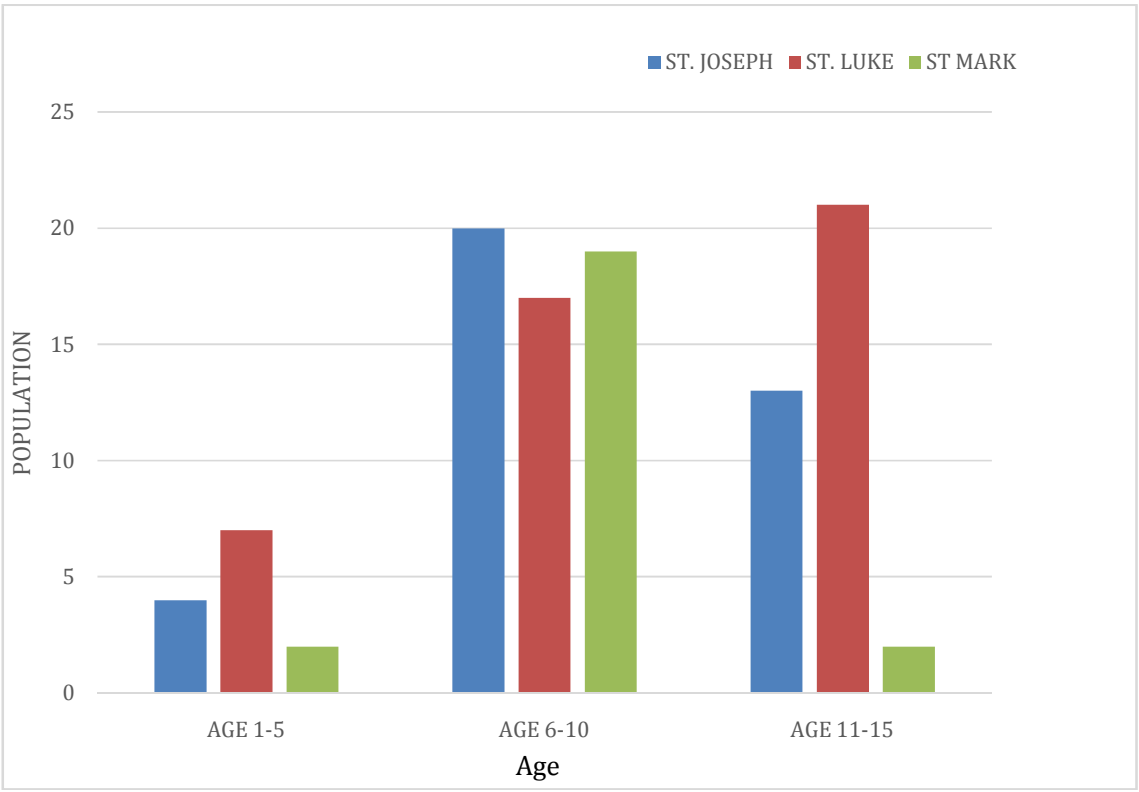

Fig. 1. Prevalence of infection by age group in the study population before treatment

of the 105 (19.9%) infected pupils were still infected (Table 3). The drug showed an overall parasitological cure rate of 93.3% and produced a significant reduction in cases of haematuria, from 37 (7.0%) to 4 (3.8%). There was a significant reduction in prevalence by age after the treatment with single dose praziquantel since only 3 pupils in the age group 6-10 years and 4 pupils in 11-15 were the ones still infected (Fig. 2). Gender prevalence reduced though the percentage of a positive male was still higher than female as observed in the pre-treatment analysis (Fig. 3).

Chi-square (χ^2) test showed that there was no significant relationship (P>0.05) between age group and prevalence of infection (χ^2=5.223, Sig=0.073) after the administration of praziquantel, but there was a significant relationship (P<0.05) between gender and prevalence of infection after treatment (χ^2=537.6, Sig=0.000). Male pupils still had a higher prevalence of 4.8% compared with the female 1.9% (Table 4). Similarly, there was a marked reduction in the intensity of infection (Table 5), in all the schools in the village following the single dose therapeutic regimen. Geometric egg mean counts dropped from 25.22 before treatment to 5.62 and the percentage reduction of geometric egg mean count (GMEC) was 77.72% after the administration of Praziquantel.

Table 4. Prevalence of urinary schistosomiasis in the pupils according to gender post treatment

School	Total no examined	No examined Male (%)	No positive Male (%)	No examined Female (%)	No positive Female (%)	Haematuria (%) Male	Female
St. Joseph	27	28 (75.7)	2 (5.4)	1 (2.7)	9 (8.3)	2 (3.9)	0 (0)
St. Luke	45	30(66.7)	2 (4.4)	0 (0)	15 (24.6)	1 (4.4)	0 (0)
St. Mark	23	12 (52.1)	1 (4.3)	1 (4.3)	11 (18.6)	1 (3.2)	0(0)
Total	105	70 (66.7)	5 (4.8)	2 (1.9)	35 (15.4)	4(3.8)	(0.0)

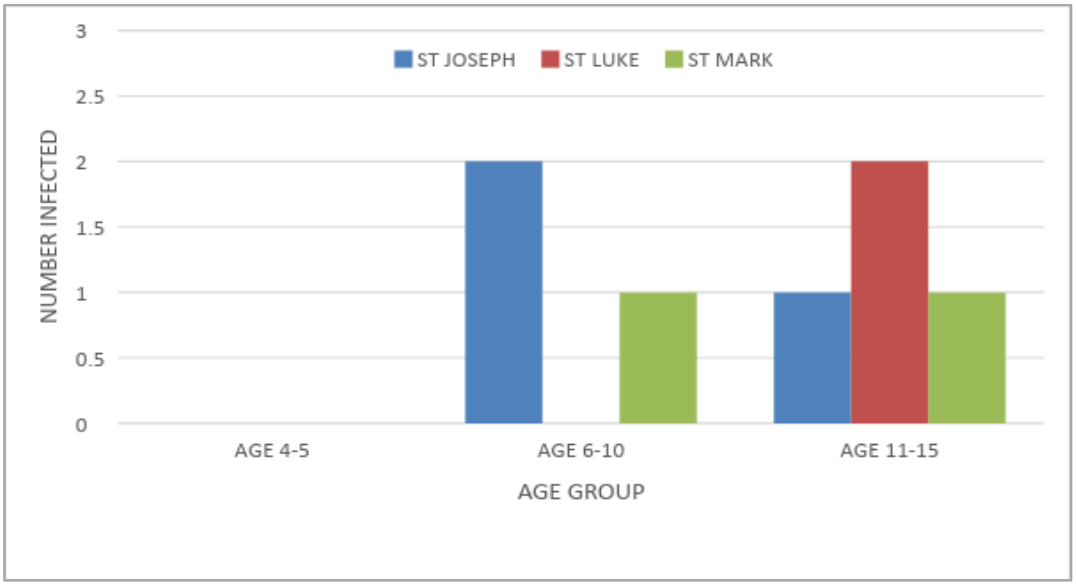

Fig. 2. Infected pupils with urinary schistosomiasis by age group after treatment

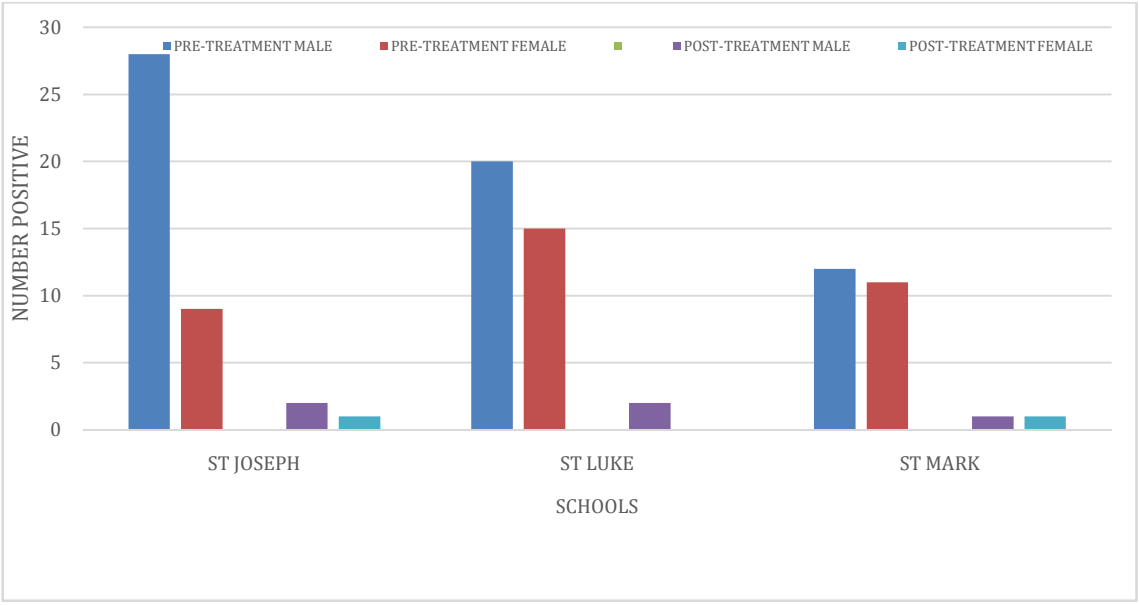

Fig. 3. Infection in pupils according to gender before and after treatment with praziquantel

Table 5. Intensity of infection in the study group before and after praziquantel administration

School	Geometric Mean Egg Count (GMEC) before treatment	Geometric Mean Egg Count (GMEC) after treatment	Percentage reduction of Geometric Mean Egg Count (GMEC)
St. Joseph	7.81	1.53	80.41%
St. Luke	10.34	2.39	76.89%
St. Mark	7.07	1.70	75.96%
Total	25.22	5.62	77.72%

4. DISCUSSION

Schistosomiasis remains one of the major health problems among school-aged children in Oke-Igbo. Urinary schistosomiasis among school children seems to be receiving more public health attention in the tropics especially in Nigeria. A high intensity of infection implies repeated exposure to infection which may be the case in this research as previously identified by Oniya and Odaibo [24]. Low prevalence of 19.9% before treatment may have resulted from increased awareness and some form of intervention carried out in the village. Similarly, Oniya and Olofintoye [25] reported a lower prevalence of 18% in Ifedore Local Government Area of Ondo state. However, the inherent socio-cultural behaviour in the village and interrupted control programmes may always expose them to re-infection, thus making absolute control very tedious [26].

The findings of this research are similar to the results in other parts of Nigeria which have shown endemicity of *S. haematobium* infection in the rural areas. Okoli et al. [7] reported a similar prevalence of 11.3% and 18.7% in Ohaji/Egbema LGA, Imo State. While Oniya et al. [27], also reported the prevalence of urinary schistosomiasis among primary school pupils in Ipogun, a rural community in Ondo State as 18%. Higher prevalence rates in some communities known to be endemic for urinary schistosomiasis in Western Nigeria were also reported. Odaibo et al., reported an overall prevalence of urinary schistosomiasis in a community in Ondo state as 30.5%. Also, Akinwale et al. [28] as well as Agi and Awi-waadu [29] obtained higher prevalence of 54.6% and 51.9% in Ogun State and the Niger-Delta respectively. Ugbomoiko et al. [30], also reported a prevalence of 62.0% in two peri-urban communities of south-western, Nigeria, unlike the lower prevalence rate observed in this findings.

The relatively lower prevalence of urinary schistosomiasis as indicated by this result compared to those reported by others may be due to government intervention via chemotherapeutic treatment and enlightenment of the populace on the risk factors of the infection. Although inherent cultural and communal practices such as low literacy, the presence of contaminated water bodies and activities like washing, fetching of water for domestic purposes, fishing, bathing and swimming take place alongside other activities like collecting edible snails for feeding or selling, predisposes inhabitants of the community to infection/reinfection.

Urinary schistosomiasis had a higher prevalence among the male pupils than their female counterparts, 23.3% was recorded for the male pupils while a prevalence of 15.4% was recorded for the female pupils before treatment. This is also similar to the findings of other researchers. Suleiman et al. [31], found higher prevalence in male than female in Ondo and Lagos states respectively. Uneke et al. [32] in the Niger-Delta, Agi and Awi-waadu [29] in Ebonyi State also found similar results reporting male pupils having a higher prevalence than female. The prevalence of *S. haematobium* in the Imo state of Nigeria showed 108 male positive cases which are higher than 100 female positive cases [33]. The generally lower prevalence rate among the female pupils when compared to the male pupils is suggestive to the higher tendencies of water contact among the males through swimming, playing and engagement in other activities along streams and rivers which predisposes them to the infection. However, some studies reported that sex-related prevalence is not significant in the distribution of urinary schistosomiasis but could differ due to some variations in behaviour and cultural practices regarding water uses and contact [34]. This result revealed that pupils in the age group 6-10 years had the highest followed by the age group 11-15years while the group 4-5 years had the lowest in the 3 schools before treatment. Most of the infected pupils were male, this is suggestive to the fact that female pupils are more cautious of their body and have lesser water contact activities, unlike the male who swim in water, indulge in fishing activities and so on.

Chi-square (χ^2) test showed that there was a significant difference between age group and prevalence of infection before treatment ($P<0.05$). The high prevalence of infection observed in the older age groups may probably be as a result of pupils in this age group frequently engaging in activities that bring them to contact sites than those of younger age that are mostly under parental care. In a similar study carried out by Oniya and Jeje [35], they recordeda high prevalence of infection between age group 11-15yrs as well. Taylor and Francis [36] found that children aged 10-14 years had higher prevalence and intensities of infection than those in other age groups studied. Also, the prevalence of schistosomiasis in a study that

covers all the local government areas of Edo state, Nigeria was found to be age dependent [10].

Praziquantel remains the drug of choice for the treatment of schistosomiasis in spite of cases of low cure rates that have been reported in some areas. As there have been reports of therapeutic failures [37], constant surveillance of praziquantel efficacy is important while we wait for the discovery and development of more potent drugs. It would also be beneficial to repeatedly investigate the therapeutic doses of Praziquantel at different time intervals since it has been reported that repeated doses have a higher efficacy compared to single treatment in areas that are endemic [38]. Administration of Praziquantel in a single oral dose at 40mg/kg body weight showed 93% parasitological cure rate 3 months post-treatment and also the intensity of infection reduced remarkably and chi-square test showed a statistical significance to this effect. Similarly, Oniya et al. [27] reported 80% parasitological cure rate 3 weeks post treatment in Ipogun Community, Ondo State.

Post treatment assessment revealed a major significant reduction in prevalence by gender, that of male 70 (23.3%) reduced to 5(4.8%) which was still higher than that of the female which reduced from 35 (15.4%) to 2 (1.9%). It is suggestive that male pupils had more water contact than the female because there was a significant ($P<0.05$) relationship between gender and *S. haematobium* infection as recorded in this study. Prevalence by age group also reduced remarkably though pupils in the age group 6-10 years and 11-15 years had higher prevalence rate, while none in 4-5yr age group was infected. Absenteeism from school was also one of the constraints of achieving disease control as some of the pupils were absent on days sampling was done as well as during the administration of drugs.

Presently, disease control is centred on chemotherapy in Ondo state, however, the rate of re-infection following parasitological cure is a major concern. Interrupted control programmes may also aid re-infection thereby making eradication of the disease difficult. There is need to include infants and pre-school children in the schistosomiasis control programme [9] because pupils less than 4 years of age were not screened, there is still need for further studies on the safety of praziquantel administration for treatment of infants below four years in endemic countries.

5. CONCLUSION

This research revealed low prevalence and intensity of schistosomiasis infection among school pupils in Oke-Igbo, though lack of potable water supply, the proximity of schools and homes to streams put schoolchildren at high risk of exposure to infection and re-infection. Praziquantel is therefore still effective and seems to be a reliable drug of choice in chemotherapy in the study area. Constant monitoring of drug resistance should be a priority since PZQ is the only available widely-used drug.

Schistosomiasis control programme in endemic communities such as Oke-Igbo requires constant intervention and enlightenment of residents on risk factors that predispose to infection and the need for proper sewage disposal. Molluscicide measures could also be adopted. However, there is a need for more political commitment as the government should be more concerned about the provision of basic social amenities such as toilet facilities at strategic places in communities and also ensure that people in rural areas have access to potable water other than the usual chemotherapeutic measures to reduce transmission and aid elimination.

CONSENT

Consent was sought from the Village chieftains, Parents and Teachers of the Pupils before the commencement of the survey. The local Primary health care coordinator in the village was also contacted before the survey began. Teachers were aware of the results and made it known to parents. Infected pupils were then treated with praziquantel.

ETHICAL APPROVAL

The aim and objectives of the research was explained to the Ondo state Ministry of health, after which the ethical committee granted the request for a clearance and gave an approval. Moreover, the survey was in line with the routine state chemotherapeutic campaign.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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