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Water Contact! One Risk Too Many: Risk Factors Associated with *Schistosoma haematobium* infection in Osun State, Nigeria

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Abstract

Urinary schistosomiasis (US) is a significant public health problem to humans globally, particularly in sub-Sahara African countries. This study was carried out among 427 residents of Aye-Oba and Aye-Amodo in Ife South Local Government Area of Osun State, Nigeria. Their urine samples were examined by microscopy for the egg (s) of *Schistosoma haematobium* using a standard parasitological technique of sedimentation. The result showed that a total of 32.6% were positive for *S. haematobium* infection. Infection significantly varied among sex and age groups ($p<0.05$). Moreover, students/unemployed had the highest prevalence 52.1% compared to skilled workers with none positive for *S. haematobium* infection. Similarly, those with primary education recorded highest S. haematobium infection compared with those who had tertiary education with none positive for infection. Annual family income also played a major role as those with income ≤ ₦360,000 annually had the highest infection compared to those who earned ≤ ₦1,200,000 annually who recorded only 10.0% prevalence rate. Other variables including source of water, types of toilet and water contact activities also played a significant role in the transmission of urinary schistosomiasis. Thus, appropriate mitigating measures should be employed in the control of urinary schistosomiasis in the study area.

Keywords: *Schistosoma Haematobium*; Schistosomiasis; Risk factors; Water Contact; Prevalence

Introduction

Urinary schistosomiasis has been an age long, persistent disease of public health concern to man. It was discovered by Theodor Bilharz, a German scientist in 1851. It is commonly known as schistosomiasis. Schistosomiasis is an acute and chronic parasitic infection caused by trematode blood flukes of the genus *Schistosoma* and family Schistosomatidae [1]. Five species are of medical importance to man, causing either urinary schistosomiasis or intestinal schistosomiasis, depending on the species. However, two species namely *Schistosoma haematobium* and *Schistosoma mansoni* are the predominant species in the Sub Saharan Africa [2,3].

The disease is of a significant public health problem, especially in Sub-Saharan Africa, impacting approximately 11 million people in the region [4]. It is estimated that over 250 million people are affected, with 200 million deaths recorded annually, and another 779 million individuals are at risk of contracting the disease [5,6]. Notably, Sub-Saharan Africa accounts for 90% of the world's case of schistosomiasis. It is a neglected tropical disease that has received limited attention, ranking second only to malaria in terms of prevalence, with Nigeria being the most affected African country [6-9].

It is a widespread waterborne disease with a complex and complicated transmission cycle. The life cycle involves

two hosts: a snail intermediate host of the genus *Bulinus* and man [10,11]. Infected humans release viable eggs into freshwater bodies, where the eggs hatch into miracidia, which then infect the snail. Inside the snail, the miracidia develop into cercariae (the infective stage), which are released back into the water. The cercariae penetrate human skin and migrate through the bloodstream to the liver, where they mature and begin reproducing. The adult worms migrate to the urinary bladder, from where the eggs are released into the environment, restarting the cycle [12,13]. Clinical symptoms of schistosomiasis include blood in urine (haematuria), painful urination (dysuria), frequent urination, hydronephrosis, and bladder cancer [7,13]. The disease also contributes to malnutrition, anemia, impaired learning, reduced physical abilities, and diminished productivity [7,10,14].

Schistosomiasis is closely linked to poverty, and it tends to thrive in areas where access to clean water for drinking and other domestic chores is scarce [13,14]. Several environmental, socio-economic factors, lifestyle and behavioral patterns could contribute to the spread of the disease. Communities living near stagnant or slow-moving water bodies are at greater risk, and a lack of adequate sanitation facilities exacerbates the situation [15-20]. Lack of understanding of its mode of transmission and occupational hazards is also significant, with fishermen, farmers, and workers in construction or dam sites being particularly vulnerable [21-24]. Age and sex have also been implicated as risk factors. Among the groups most susceptible to infection are school-aged children, preschoolers, and women [15].

Several previous studies had focused on school aged children, but this cross-sectional study included all ages less than 70 years. The study aimed to investigate the prevalence of urinary schistosomiasis and its associated risk factors among residents of two rural communities in Osun State, Nigeria.

Materials and Methods

Study Location

This research was conducted in Osun State, South-Western Nigeria, with Osogbo as the capital city. It has a land area of 8,521 square kilometers with a population density of 520.6 per square kilometer. The state experiences two seasons: wet and dry, with an average maximum temperature of 29°C and annual rainfall of 1800mm. Agriculture (farming) being the predominant occupation. The exact study sites were Aye-Oba and Aye-Amodo communities within Ife South Local Government Area of Osun State. The sampling sites are about forty minutes' drive from the ancient city of Ile-Ife, and it lies between longitude 04˚E and 05˚S and latitude 05˚55 N and 08˚07W [25]. Both communities are predominantly rural as there is no infrastructural development there. A river called Aye River is the main source of water supply for domestic and occupational purposes.

Ethical Clearance

Ethical approval for the research was obtained from the Osun State Ministry of Health, and verbal consent was gathered from participants over 18 years, while assent for minors was obtained from their parents and guardians as the case may be. Approval from village heads was also sought, and they were briefed on the aims and purpose of the study. The village heads informed their communities, and willing participants gathered at village squares for further explanation and instructions.

Collection of Sample

A total of 427 participants were successfully recruited for the study. The sample size was arrived at following models [21,22]. This cross-sectional study was conducted from March to July 2024, following WHO guidelines. Participants provided urine samples in sterile bottles for parasitological analysis and blood samples were also collected from willing participants for laboratory investigations. The midstream urine samples were collected between 10 a.m. and 2 p.m. to maximize the chances of detecting Schistosoma haematobium eggs [26,27]. A structured questionnaire was administered to gather personal, demographic, socioeconomic, and behavioral data. The questionnaire was translated when necessary, and results were carefully matched with participant samples to ensure accuracy.

Examination of Urine Samples

Urine samples were analyzed for the presence of Schistosoma haematobium eggs through microscopy. Each sample was centrifuged, and the sediment was examined under a microscope for the characteristic eggs with terminal spines. The intensity of infection was classified into light (1-49 eggs/10ml) or heavy (50+ eggs/10ml) [18,28]. All laboratory investigations were conducted at the College of Health Sciences, Obafemi Awolowo University, Ile-Ife.

Data Analysis

All data were prepared into an excel sheet and exported into Statistical Package for Social Sciences (SPSS) software version 21 for statistical analysis. Frequency and percentage were used for socio-demographic characterization and the risk factors associated with schistosomiasis infection. Pearson Chi squared was used to test for correlations between demographic, socioeconomic and behavioral variables with the rate of infection. *P* value for all tests was taken as <0.05 to indicate a level of significance at 95% confidence interval (CL).

Results

Socio-Demographic Characterization of Sampled Population

Table 1 showed the socio-demographic distribution of the sampled population. A total of 427 urine samples were collected from males (52.5%) and female (47.5%). The sampled population was aged from less than 10 years to less than 70 years. The mean age of the sampled population was 35.5. The overall prevalence rate of infection was 32.6% (139/427).

Prevalence Based on Location, Age and Sex

Table 2 showed that 32.6% (139) of the sampled population were positive for *Schistosoma haematobium* infection. This result also indicated that prevalence was significantly (p=0.004) higher in males with 38.8% than females with 25.6%. Individuals aged 11-20 years had the highest prevalence of 53.1% (60). This was followed by individuals aged 1-10years with a prevalence of 52.8% (66), while the lowest prevalence of 0% was recorded among adults aged 51-60 years. This result showed a significant difference (p=0.001) in the prevalence of schistosomiasis between age group. Similarly, participants from Aye-Amodo community had a higher prevalence of 33.3% compared with participants from Aye-Oba community with a prevalence of 31.9%, there was no significant difference in the prevalence of schistosomiasis by locations.

Prevalence and Risk Factors Associated with Schistosomiasis

The result showed that students and the unemployed participants had a higher prevalence of 52.1% (126) while the employed participants had a prevalence of 7.0% (13). Most participants (65.3%) had primary education. The result also showed that participants with primary education had the highest prevalence of 44.1% (123), while prevalence was 0% (8) in those with tertiary education. This finding also indicated that participants whose annual family income was ≤₦360,000.00 (minimum wage in Nigeria at the time of this study) had the highest prevalence of 49.3% (72) as shown in Table 3.

Apparently, 54.3% of the sampled population had lived in the environment for over ten years, however those that had lived in the locations between 6 and 10 years had the highest prevalence of 53.9% as shown in table 3. The sampled population consisted mostly of students and unskilled workers (farmers) and it is interesting to note that 52.0% of the participants had annual family income of ≤₦600,000.00 (six hundred thousand naira only).

Prevalence and Risk Factors of Water Contact Activities

Results showed that the entire sampled population visited the Aye River for one reason or the other. Most houses were built using mud with no toilet facilities. 91.8% of the sampled population visited the bush close to the river for defecation, as they could easily get water to clean up. A prevalence of 34.7% was obtained among those that visited the bush to defaecate. Table 3 showed a significant difference in the prevalence of urinary schistosomiasis based on the type of toilet. The river remains the main source of water supply to 97.0% of the sampled population, while only 3.0% had another source of water which is the well water. It is noteworthy to mention here that both communities have a borehole each. Aye-Oba borehole is basically meant for the health centre, but residents have the privilege to get water from it especially for drinking. However, Aye-Amodo has a newly built, solar powered borehole, but the residents still prefer to go to the river, claiming that the borehole is constructed up the hill, so they would rather slope down to the river than climbing to access the borehole.

Table 4 further showed the prevalence of infection based on water contact activities. The result indicated that individuals that had dual or multiple reasons to visit the river had more frequency with the water and this was significantly (p=0.001) associated with contracting urinary schistosomiasis. This can further be related with the individuals that visited the river for dual purpose of bathing and washing (36.3%) and individuals that visited with dual purpose of bathing and fishing (10.7%). Hence the result of this present work showed that water contact activities are significantly associated with the transmission of schistosomiasis.

Variables	Frequency	Percentage (%)
Location		
Aye-Oba	238	55.7
Aye-Amodo	189	44.3
Gender		
Male	224	52.5
Female	203	47.5

Age Group (Years)		
10-Jan	125	29.3
20-Nov	113	26.5
21-30	29	6.8
31-40	25	5.9
41-50	42	9.8
51-60	26	6.1
61-70	67	15.7

Table 1: Socio-demographic distribution of the sampled population of Aye-Oba and Aye-Amodo communities of Osun State, Nigeria (n=427).

Variables	No. Examined	No. Positive	Prevalence (%)	*P* Value
Gender				
Male	224	87	38.8	0.004
Female	203	52	25.6	
Total	427	139	32.6	
Age Group				
10-Jan	125	66	52.8	0.001
20-Nov	113	60	53.1	
21-30	29	2	6.9	
31-40	25	2	8	
41-50	42	4	9.5	
51-60	26	0	0	
61-70	67	5	7.5	
Total	427	139	32.6	
Location				
Aye-Oba	238	76	31.9	0.759
Aye-Amodo	189	63	33.3	
Total	427	139	32.6	

Table 2: Prevalence of *Schistosoma haematobium* infection in relation to sex, age, and location (n = 427).

Variables	No. Examined	No. Positive	Prevalence (%)	*P* Value
Location				0.759
Aye-Oba	238	76	31.9	
Aye-Amodo	189	63	33.3	
Total	427	139	32.6	
Gender				0.004
Male	224	87	38.8	
Female	203	52	25.6	
Total	427	139	32.6	
Age Group				0.001
10-Jan	125	66	52.8	

20-Nov	113	60	53.1	
21-30	29	2	6.9	
31-40	25	2	8	
41-50	42	4	9.5	
51-60	26	0	0	
61-70	67	5	7.5	
Total	427	139	32.6	
Occupation				0.001
Student/Unemployed	242	126	52.1	
Unskilled worker	185	13	7	
Skilled worker	0	0	0	
Educational status				0.001
No formal education	44	3	6.8	
Primary education	279	123	44.1	
Secondary education	96	13	13.5	
Tertiary education	8	0	0	
Annual family income				0.001
≤₦360,000.00	146	72	49.3	
≤₦600,000.00	222	61	27.5	
≤₦1,200,000.00	50	5	10	
≥₦1,800,000.00	9	1	11.1	
Years of residency				0
0-5	67	16	23.9	
10-Jun	128	69	53.9	
>10	232	54	23.3	

Table 3: Prevalence of *Schistosoma haematobium* infection in relation to socio-demographic characteristics among the sampled population in Aye-Oba and Aye-Amodo, Osun State, Nigeria.

Variables	No. Examined	No. Positive	Prevalence (%)	*P* Value
Source of water				0.18
River	414	137	33.1	
Well	13	2	15.4	
Type of toilet				0.004
Bush	392	136	34.7	
Water closet	16	0	0	
Pit	19	3	15.8	
Water Activities				0
Bathing	31	3	9.7	
Swimming	6	0	0	
Washing	41	3	7.3	
Fishing	2	0	0	
Bathing & Washing	80	29	36.3	

Bathing &Swimming	7	0	0	
Bathing & Fishing	28	3	10.7	
Bathing, Washing & Swimming	178	97	54.5	
Others	54	4	7.4	

Table 4: Prevalence of *Schistosoma haematobium* infection in relation to source of water, toilet facility and water contact activities among the sampled population of Aye-Oba and Aye-Amodo in Osun State, Nigeria (n=429).

Discussion

This revealed that occupation, educational status, annual family income, source of water, types of toilet and water contact activities significantly enhance the transmission of urinary schistosomiasis in the study area. A total of 139 individuals out of the 427 individuals that participated in this study were positive for *Schistosoma haematobium* infection. This represents 32.6% of the sampled participants. Sex pattern of infection showed that 38.8% of the males were infected compared with 25.6% of the female. This result falls within the provisional prevalence of 0-84% of Nigeria Master Plan on Neglected Tropical Disease [29]. However, the result of this study is higher than that of World Health Organization report of 9% [9]. It is also higher than previously reported prevalence obtained in Osun state and in other parts of Nigeria [24,30-36]. The lower prevalence rate recorded in previous studies within the South Western States of Nigeria as compared with the present sample locations could be as a result of public health enlightenment and exposure of those other communities to mass drug administration, which is a privilege yet to be extended to Aye-Oba and Aye-Amodo in recent times. A prevalence of 29.6% obtained by Gyuse KI in a previous study in the same location of Aye-Oba about fifteen years ago indicated that the disease is endemic and remains unabated in the communities [31]. Higher prevalence rate was reported in some parts of Osun State and other South Western States of Nigeria compared with the 32.6% obtained in this present study [37-41].

The result of this study further revealed a significant difference ($p<0.05$) in the prevalence of schistosomiasis between sex of the sampled population, with the males having a higher prevalence rate of 38.8% while the females have 25.6%. This is consistent with most previous results [24,29,30,33,35,36,39,41]. This has been attributed to some water contact activities such as swimming, fishing, open bathing and water sport that are peculiar to the males [4,24,37]. The results from this findings showed that individuals aged 11 – 20 years had the highest prevalence rate of 53.1% with a significant difference in the rate of acquisition of schistosomiasis and the age groups of the participants. This is consistent with the reports of [4,29,35-37]. This could be convincing as individuals in this age category are very active, energetic and adventurous involving themselves with much water activities.

A higher prevalence rate of 52.1% (126) was recorded for the unemployed individuals including the students while the employed participants had a prevalence of 7.0% (13). This can be based on the premise that the unemployed individuals have ample time to laze around water bodies. The result also showed that participants with primary education had the highest prevalence of 44.1% (123), while prevalence was 0% in a few with tertiary education. This result indicated that the few participants with tertiary education are aware of the mode of transmission of the infection. The finding on annual family income indicated that participants whose annual family income was ≤₦360,000.00 (minimum wage in Nigeria at the time of this study) had the highest prevalence of 49.3% (72). This result is consistent with various previous reports that had attributed the disease to poverty.

The result posited that individuals that had dual or multiple reasons to visit the river had more frequency with the water and this was significantly associated with acquisition of the infection. The highest prevalence of 54.5% was obtained among individuals that had many reasons to visit the river which is contaminated with the infective stage of *Schistosoma haematobium*. This result is in agreement with most previous reports which suggested that frequency of contact with water, depth of submerging in water and the duration of submerging in water play a significant role in the transmission process [9,24,29,36,37].

Schistosomiasis affects all age groups within a population, but children within the age bracket of 5-15 years are most vulnerable group [18]. Due to the complexity in the life cycle of *Schistosoma* spp and the ease of re-infection, an integrated approach that is capable of halting the transmission of the infection, thereby leading to a drastic reduction in prevalence is desirable [7]. This should include provision of safe drinking water, mass drug administration, improved sanitary conditions, public health education, snail control and a strong drive at bringing people out of poverty since the disease is associated with poverty [9,16]. Annual preventive chemotherapy using praziquantel has been recommended for all ages in hyper endemic areas [18]. The snail population

can be drastically reduced by treating the snail environment with niclosamide which is quite effective against all forms of the parasites found in the snail and the snail host [42]. Alternatively, a biological control of introducing a natural predator into the habitat of the snails can be adopted [17]. The importance of reducing contact with fresh water body was noted as a panacea to the scourge of schistosomiasis, while not undermining the effect of public health education and awareness, as most people are ignorant of the mode of transmission of the disease [43]. WHO initiative of WASH (Water Sanitation and Hygiene) has also been largely advocated which is aimed at improving the sanitary and general hygiene of the population. The provision and use of protective garments to high risk groups such as fishermen have been suggested [20].

Conclusion

The prevalence of 32.6% obtained from this study placed Aye-Oba and Aye-Amodo communities in Ife South Local Government of Osun State as hyper-endemic zones for schistosomiasis [9]. There is therefore an urgent need for the government to ensure the provision of potable water that can be easily assessed. Public health education that would explain to the level of understanding of these rural dwellers is equally important, the importance of behavioural and lifestyle changes should be encouraged. All of these measures coupled with periodic preventive chemotherapy would facilitate the elimination of this disease.

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