Prevalence and risk factors associated with urogenital schistosomiasis among primary school pupils in Nigeria

A.M. Onyekwere, Olivier REY, M.C. Nwanchor, M. Alo, E.K. Angora, Jean-François Allienne, Jérôme Boissier

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Onyekwere, A.M.[1,2], Rey, O.[2], Nwanchor, M.C.[3], Alo, M.[4], Angora, E.K.[5], Allienne, J.F.[2], Boissier, J.[2]

1 Department of Biology, Alex Ekwueme Federal University, Ndufu-Alike, Ikwo, Ebony State, Nigeria. onyekwereamos@gmail.com (A.O.M)
2 IHPE, Univ. Montpellier, CNRS, Ifremer, Univ. Perpignan Via Domitia, Perpignan, France. amosonyekwere@univ-perp.fr (A.O.M); boissier@univ-perp.fr (J.B); Olivier.rey@univ-perp.fr (O.R); allienne@univ-perp.fr (J-F.A)
3 Department of Zoology, Nnamdi Azikiwe University, Akwa, Anambra State, Nigeria. mnwanchor@gmail.com (M.N.C)
4 Department of Microbiology, Alex Ekwueme Federal University, Ndufu-Alike, Ikwo, Ebony State, Nigeria. gianimarg@gmail.com(M.A)
5 Unité de formation et de Recherche Sciences Pharmaceutiques et Biologiques, Universite Felix Houphouet-Boigny, BPV 34, Abijan, Cote d'lvoire; angorakpongbo2005@yahoo.fr (E.K.A)

Abstract: Urogenital schistosomiasis is a neglected tropical disease that is endemic to Nigeria and one which continues to pose a public health problem especially among school-age children in rural communities. This study was carried out in remote areas where most of the people depend on natural water bodies and rainwater for their daily water needs. The present research investigates the prevalence of urogenital schistosomiasis and the significant risk factors associated with the infection among primary school children in Nigeria. From August 2019 to December 2019, a total of 5,514 primary school-age children from twelve sites were diagnosed with the presence of *Schistosoma haematobium* eggs in their urine. We also collected socio-demographic, sociocultural, and socioeconomic indices and data on behaviors (e.g contact frequency with freshwater bodies) for each diagnosed individual using a questionnaire. Associations between each of these variables and disease infection were tested using multivariate logistic regression. A total of 392 of the 5514-urine samples were positive for the infection, the overall prevalence reached 7.1% and ranged from 4.6% (East Nigeria) to 15,9% (West Nigeria). Multivariate logistic regression analyses showed that the significant risk factors associated with *S. haematobium* infection are frequent contact with freshwater bodies (rivers/steams), with an adjusted odds ratio (AOR) of 4.92; 3.34-7.24, washing/swimming, AOR: 46.49; 27.64-78.19, and fishing, AOR: 11.57; 8.74-15.32. For socioeconomic factors, primary education of fathers resulted in an AOR of 1.63; 1.01-2.45 was significantly associated with the infection. The socio-demographic factor for the 12-14 year age group had an AOR of 1.68; 1.21-2.33, and was also significantly associated

with the disease. Nigeria remains endemic for urogenital schistosomiasis as indicated by the data obtained from all of the study site sites, and it is clear that efforts need to be intensified in order to control and eradicate the disease throughout the country.

Keywords: Nigeria; urogenital schistosomiasis; school-aged children; prevalence; risk factors

1.**Introduction**

Globally, schistosomiasis is a neglected tropical disease (NTD) and is caused by dioecious blood fluke (digenetic trematodes) of the genus *Schistosoma* (Atalabi et al., 2018). It is ranked as the second parasitic disease after malaria based on socio-economic and public health importance. It is the most prevalent water-borne disease that occurs among the rural populace. The parasite is transmitted by a specific freshwater intermediate molluscan host, while humans of all age groups act as the definitive host, (Uchendu, et al., 2017). It is estimated that nearly 700 million people live in areas where the disease is endemic. Approximately 200 million people are infected in 76 countries around the world (Ossai , et al., 2014), with sub-Saharan Africa and some parts of Asia reporting the highest endemicity. Sub-Saharan Africa accounts for 90% of the infected cases, and it is estimated that about 11,700 people die from this disease annually in this region (Dawet , et al., 2012).

Of the six *Schistosoma* species that infect humans (*S. haematobium*, *S. mansoni*, *S. japonicum*, *S. intercalatum*, *S. mekongi* and *S. malayensis*) (Manson, et al., 1987), three species (*S. haematobium*, *S. mansoni* and *S. intercalatum*) are present in Nigeria. The urogenital schistosomiasis caused by *S. haematobium* occurs at a higher frequency in remote areas of the country. Nigeria is one of Sub-Saharan Africa's most heavily impacted countries with respect to both urinary and intestinal schistosomiasis, accounting for almost 14% of the disease worldwide, (Hotez, , et al., 2012, Herrick, et al., 2017). As a result, Nigeria also requires the greatest intervention to help control and eradicate disease (Uchendu et al., 2017). The first reported case of schistosomiasis in Nigeria was in 1908, (Bishop, (2017)) and numerous studies are available on the epidemiology, prevalence and risk factors associated with this disease. It is worth noting that some of these reports conflict with one another (Emmanuel, et al., 2017). For many areas in Nigeria, no reliable systematic report has been published on the epidemiological status of this disease (Houmsou et al., 2011), and it was only recently, 4 June 2015, that Nigeria's Federal Ministry of Health (FMOH) officially released the first epidemiological data on the prevalence of this disease (Global Network Neglected Tropical Diseases, 2015). The data showed that roughly 24 million people in Nigeria are at the risk of infection and that there is a prevalence of almost 9.5% (Bishop, 2017). The control program initiated by the FMOH, State Ministry of Health, and other institutions, involves the use of chemotherapy through Mass Drug Administration (MDA), and administers praziquantel to infected individuals or to those at the risk of infection (Ejike et al., 2017). Despite Government efforts, and in spite of contributions by Research Institutions, Non-Government Organizations (NGOs) and Faith Based Organizations (FBOs), the disease remains unabated (Ejike, et al., 2017). This may be a result of several hurdles encountered in the process, including, geographically remote areas, ethnic violence, religious crises as well as the marshy stream or river systems that are favorable for the multiplication of the snail intermediate host (Yauba et al., 2018). It has been suggested that integrating school-based health education with preventive chemotherapy would result in significantly lowering the prevelance of the disease. Further, it was suggested that this approach would help to prevent re-infection, reduce the resurgence in the frequency of infection after treatment and help to minimize drug resistance by the parasites (Ajakaye et al., 2017). Previous studies have provided information on the endemicity of this disease in one or several communities within the same geographical coverage (Opara, et al., 2021). However, the data on this subject are based on results which were collated from studies that were not only conducted at different times but by different researchers (Abdulkadir, , et al., 2017).

In this survey, we used a simple and rapid method of screening patients that yielded results within five minutes. Furthermore, we used questionnaires in addition to conducting oral interviews with each subject to scrutinize and draw a tentative conclusion on the prevalence and risk factors associated with the disease. This study aims to provide an abundance of new information on the disease for a much broader geographical range in comparison with previous studies. Such data is crucial in order to determine the current epidemiological status of the disease.

2. **Materials and Methods**

2.1. Study Area and Study Population

This study was carried out in 12 sites across 7 states in South Nigeria, West Africa in order to provide a broad geographical coverage. Northern Nigeria was not included within this study due to security challenges. For each site, we examined urine samples from the local population. We targeted primary school-age children, from the 5 to 14-year age group, the age group known to be at the greatest risk for infection with highest intensities in endemic areas. We chose primary schools based on information obtained from previous surveys as well as those which allowed us to easily collect the required number of samples. This study was part of a standard epidemiological surveillance program and as such, was not submitted to an ethics committee. The Parent-Teacher Associations (PTA) for each of the schools were mobilized, provided with information, and each gave their approval. Informed consents for parents and pupils were obtained before samples were collected from participants. The whole school was invited to the screening. After consultations with the PTA, the head teacher directed each class teacher to organize their respective pupils for the screening. Teachers helped the youngest children complete their questionnaires.

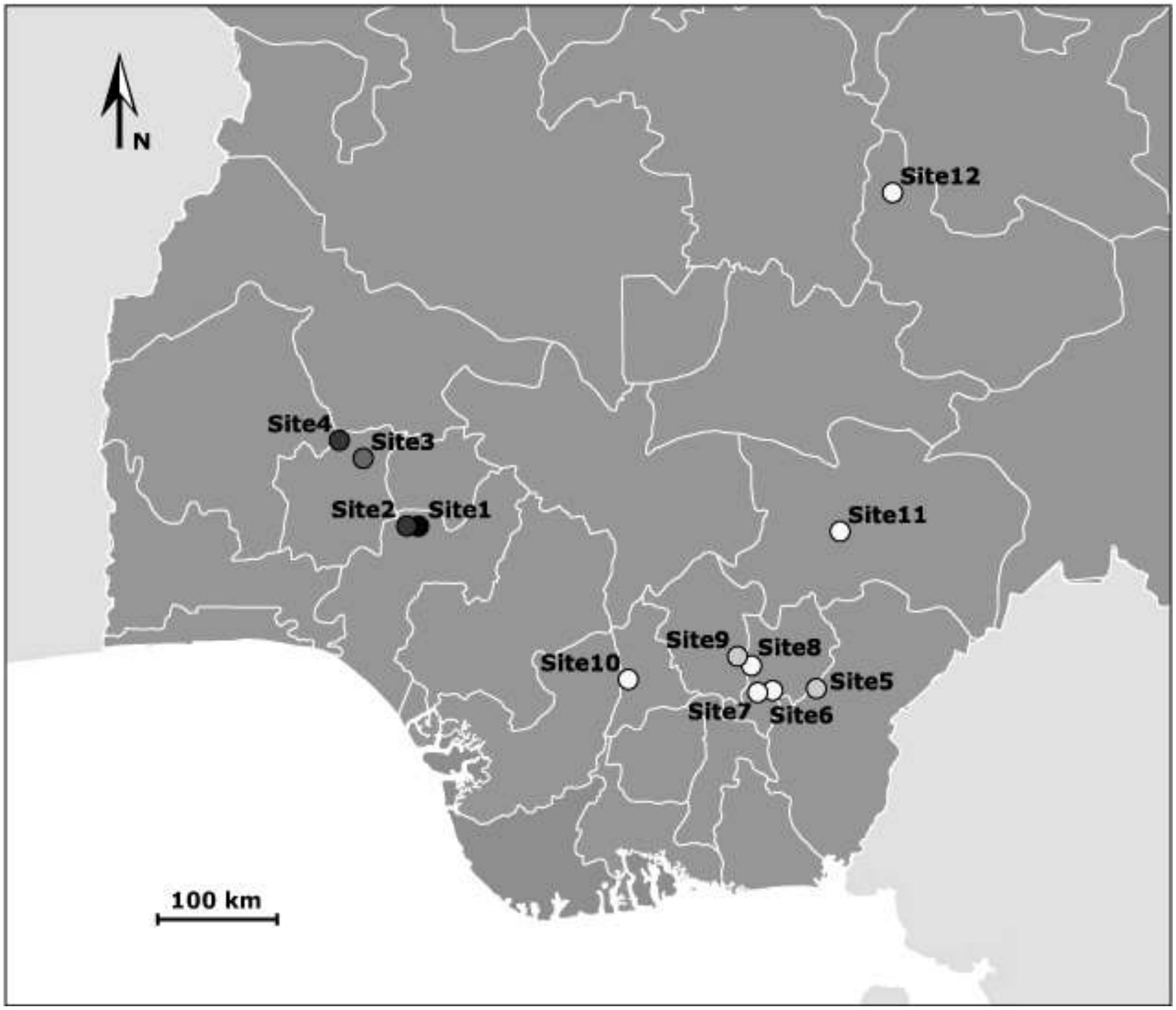

Fig 1. Map of Nigeria (West Africa), showing the sampling sites. Sampling sites were represented according to the prevalence of *S. haematobium* measured among primary school pupils (see results). Lighter circles correspond to lower prevalence, while darker circles correspond to higher prevalence observed in the study sites (see Table 2 results).

2.2 Sample Collection

Urine samples were collected between 10.00 hr and 14.00 hr, corresponding to the time of day when the excretion of *S. haematobium* is expected to be at its highest. Excretion generally peaks at 12.00hr, mid-day (Singh, et al., 2016). Only primary school children who had lived in the study area for at least a year, and whose parents or legal guardians provided oral consent, were selected. Each patient was given an 'identification code' for anonymity, and a 20ml clean labelled, plastic container for the collection of urine. We used a questionnaire to collect data on sociodemographic behaviors, such as source of drinking water, bathing, washing, farming, and fishing. Most participants visited the streams about 3-5 times per week, especially during the dry season, to collect water for domestic use. Visitation was reduced to once or twice per week during the rainy season, when rainwater became an alternative source of water. Fishing activity was predominantly carried out by males. Men and women both waded through the streams while going to and from school, to the farm or to bathe in them early in the morning before the day's activities. Other information collected included symptoms like dysuria (painful urination), haematuria (bloody urine) and the socioeconomic status of the parents or guardians. These latter information did not seem to influence the frequency at which participants had contact with the water bodies, but enabled us to identify the potential risk factors associated with the disease. A total of 5,514 urine samples were collected for urogenital schistosomiasis screening.

2.3 Parasitological Examination

On-the-spot analysis of each urine sample was performed using a rapid diagnostic technique comprised of a field microscope and a Nytrel® filter with a 40μm mesh size. Approximately 20ml of each urine sample was homogenized by shaking it vigorously and then filtering it through a Nytrel® filter, yielding a residue which was released into a small Petri dish using a wash bottle filled with commercial spring water (Mott, et al., 1982, Colley, et al., 2014). The resulting residue was examined under a binocular microscope at 20X or 40X magnifications, for the presence of a characteristic 'terminal spine' *S. haematobium* egg or of hatched miracidia. This process was performed and independently checked by two well-trained technicians. After the urine examination, each child infected with *S. haematobium* was treated with a single oral dose, 40mg/kg body weight, of praziquantel (600mg, Biltricide, Bayer, Leverkusen, Germany), through their Primary Health Centre (PHC).

2.4 Statistical Analysis

Statistical analyses were carried out for twelve parameters using STATA version 15.0 (Stata cooperation, college station, Texas, USA). Prevalence comparisons between groups (Site, Sex or Age) were tested using a univariate analysis (x^2 or Fisher's exact test). Patients were said to be positive for the infection when one or more eggs/miracidia of schistosome were seen during the microscopy examination. Participants were divided into three age groups (5-8, 9-11 and 12-14 years) for each sex. We performed statistical analyses to assess the relationship between parasitic infections and demographic, sociocultural and socioeconomic factors using multivariate logistic regression with random intercepts for sites and groups nested within sites. The risk factors investigated were domestic water source, washing, swimming, fishing, parents' occupation and parents' educational status. Associations and differences with a p-value < 0.05 were considered as statistically significant.

3. **Results**

3.1 Socio-demographic Study (Population parameter)

A total of 5,514 primary school children were tested, and more males participated (3,190, 57.85%) than females (2,324, 42.15%). The minimum, mean and maximum age was 5 years, 9.02 years and 14 years respectively, with a standard deviation of 2.84 years. Table 1 shows the demographic analysis of pupils.

Table 1: Socio-demographic characteristics of study population (n=5,514).

Variable	**Number of children**	**Percentage of the total sample (%)**
Study site/state		
1 Ipogun (Ondo)	308	5.59
2 Ilara-Mokin (Ondo)	302	5.48
3 Alie Ilie (Osun)	300	5.44
4 Lie Twon (Osun)	301	5.46
5 Ikwo (Ebonyi)	536	9.72
6 Ohaozara (Ebonyi)	548	9.94
7 Onicha (Ebonyi)	537	9.74
8 Ishielu (Ebonyi)	548	9.94
9 Nkanu east (Enugu)	572	10.37
10 Anambra west (Anambra)	539	9.78
11 Gwer east (Benue)	567	10.28
12 Jos north (Plateau)	456	8.27

Gender		
Female	2 324	42.15
Male	3 190	57.85
Age (years)		
5-8	2 579	46.77
9-11	1 596	28.95
12-14	1 339	24.28

3.2 Prevalence of *S. haematobium*

A total of 392 (7.1%) of the 5,514 urine samples were found positive for *S. haematobium*. The prevalence ranged from 4.6% in East Nigeria to 15.9% in West Nigeria. The highest prevalence was recorded in West Nigeria (sites 1-4), while the lowest were recorded in the East or the central part of the country (sites 5-12). There was a statistically significant difference among all of the study sites, $p \leq 0.001$, and two distinct clusters emerged between sites. Sites from the West (sites 1-4) had a prevalence greater than 10%; similarly, that for sites from the Est (sites 5-12) with a prevalence less than 7%. Moreover, 244 (7.6%) males were positive, while 148 (6.4%) females were positive, but no statistically significant difference in prevalence was found between the two genders ($p = 0.068$). There was a statistically significant difference in the prevalence among the age groups ($p \leq 0.001$), with the prevalence of the infection increasing with an increase in age of the patients.

Table 2: Infection status stratified by study settings, sex and age group.

Characteristic	Infection status		p-value
	Total	**Positive n (%)**	
Study site/state			***<0.001***
1 Ipogun (Ondo)	308	49 (15.91)	
2 Ilara-Mokin (Ondo)	302	37 (12.27)	
3 Alie Ilie (Osun)	300	32 (10.67)	
4 Lie Twon (Osun)	301	38 (12.62)	
5 Ikwo (Ebonyi)	536	36 (6.72)	
6 Ohaozara (Ebonyi)	548	28 (5.11)	

7 Onicha (Ebonyi)	537	27 (5.03)	
8 Ishielu (Ebonyi)	548	27 (4.93)	
9 Nkanu east (Enugu)	572	35 (6.12)	
10 Anambra west (Anambra)	539	25 (4.64)	
11 Gwer east (Benue)	567	32 (5.64)	
12 Jos north (Plateau)	456	26 (5.70)	
Gender			***0.068***
Female	2 324	148 (6.37)	
Male	3 190	244 (7.65)	
Age (years)			*<0.001*
05- 8	2 579	149 (5.78)	
09-11	1 596	121 (7.58)	
12-14	1 339	122 (9.11)	

Table 3: Univariate and multivariate logistic analyses of variables associated with the infection non-adjusted and adjusted for socio-demographic factors, socio-economic status and environmental factors. OR: Odd ratio; CI: confidence interval.

Variable	Total	Positive (%)	Crude OR (95% CI)	Adjusted OR (95% CI)
Socio-demographic factors				
Age (years)				
5-8	2 579	5.78	1	1
9-11	1 596	7.58	1.34 (1.04-1.72)	1.30 (0.94-1.81)
12-14	1 339	9.11	1.63 (1.27-2.10)*	1.68 (1.21-2.33)*
Gender				
Female	2 324	6.37	1	1
Male	3 190	7.65	1.23 (0.98-1.50)	1.14 (0.86-1.50)
Socio-economic factors				
Father's educational status				
Illiterate	843	5.34	1	1

Primary school	3 346	7.5	1.44 (1.04-1.99)	1.63 (1.01-2.45)*
Secondary school	1 169	7.53	1.44 (1.00-2.09)	1.28 (0.80-2.05)
Tertiary school	156	5.13	0.96 (0.44-2.07)	0.95 (0.36-2.47)
Mother's educational status				
Illiterate	538	6.32	1	1
Primary school	2 887	6.58	1.04 (0.72-1.52)	1.14 (0.71-1.85)
Secondary school	2 039	7.95	1.23 (0.87-1.87)	1.39 (0.85-2.27)
Tertiary school	50	12	2.02 (0.80-5.08)	2.01 (0.63-6.45)
Father's occupation				
Peasant farmer	3 925	6.93	1	1
Petty trader	991	7.47	1.08 (0.83-1.41)	1.24 (0.87-1.76)
Fisherman	214	8.41	1.23 (0.75-2.03)	1.14 (0.60-2.19)
Civil service	383	7.31	1.06 (0.71-1.59)	1.13 (0.67-1.93)
Mother's occupation				
Peasant farmer	3 643	7.05	1	1
Petty trader	1 647	6.92	0.98 (0.78-1.23)	0.77 (0.73-1.04)
Housewife	92	7.61	1.09 (0.50-2.34)	1.10 (0.38-3.10)
Civil service	132	10.61	1.56 (0.88-2.76)	1.52 (0.74-3.12)
Sociocultural factors				
Using borehole water				
No	3 003	7.89	1	1
Yes	2 511	6.17	0.77 (0.62-0.95)	0.80 (0.61-1.05)
Using river/stream water				
No	1 917	2.4	1	1
Yes	3 597	9.62	4.33 (3.17-5.92)*	4.92 (3.34-7.24)*
Washing/ swimming in river/stream water				
No	3 500	0.6	1	1
Yes	2 014	18.42	37.41 (24.0-58.29)*	46.49 (27.64-78.19)*
Fishing in freshwater				
No	4 776	3.62	1	1
Yes	738	29.67	11.23 (9.02-13.98)*	11.57 (8.74-15.32)*

* Significant *P-value*<0.05, *p*-value obtained from multivariate logistic regression with fixed effects for all explanatory variables.

The multivariate logistic regression analysis of variables on table 3 shows the relationship between urogenital schistosomiasis and sociodemographic, sociocultural and socioeconomic factors. The significant risk factors associated with *S. haematobium* infection are frequent contact with freshwater bodies (rivers/steams), washing/swimming and fishing. As expected, these results indicate a link between water contact and infection prevalence. Very few socioeconomic factors seemed to influence the infection status and only the primary education of fathers was significantly associated with the disease. The sociodemographic factor (age group 12-14 years) was also significantly associated with the infection.

4. **Discussion**

Infection with urogenital bilharziasis was found at all study sites although the prevalence was heterogeneous throughout country. The East and central parts of the country fell below the national average prevalence of 9.5%, while all of the sites in the West were slightly above the national average. A systemic review from 1994-2015, using a unified pooled population, revealed a pooled prevalence range from 31.0% to 38.50% for all regions (Abdulkadir, et al., 2017). A 50-year review by Ezeh, , et al., (2019), ranked most of our study sites (Benue, Ebonyi, Enugu, Osun and Plateau) as hyper endemic zones (>50% prevalence), while a few (Anambra and Ondo) were in moderately endemic zones (10-50% prevalence). Results of this survey showed a decrease in prevalence in most of the studied areas when compared with previously highlighted results (Table 4) . This suggests that recent efforts to fight the disease have yielded positive results. Nigeria has increased control efforts, with global partners renewing their support to eliminate the infection. Yet, risk of reinfection and transmission of the parasite is still active in many areas in Nigeria. While MDA has helped to reduce morbidity, it is not sufficient to stop transmission in many parts of the country. A long-term well-structured control approach could help to provide a more sustainable result, similar to results achieved in China, Japan and Brazil (Bergquist, et al., 2017).

Table 4: Results obtained in present study and reports by previous studies

Present Survey				**Previous Survey**	**References**
State	Sample site	Prevalence (%)	Date	Prevalence (%)	

Ondo	Ifedore	15.91	Oct 2002-Oct 2003	59.0	Oniya & Odaibo, 2006
Ondo	Ifedore	12.27			
Osun	Irepodun	10.67	Nov 2006-Jun 2007	62.0	Ugbomoiko et al., 2010
			Feb-July 2012	55.80	Awosolu, 2016
			-----	51.10	Bishop, 2017
Osun	Irepodun	12.62	-----	30.10	Igbeneghu et al., 2018
			2013-2015	5.30	Amuga et al., 2020
Ebonyi	Ikwo	6.72	-----	17.50	Nwosu et al., 2015
			July-Dec 2016	10.0	Umoh et al., 2020
Ebonyi	Ohaozara	5.11	2012-2013	15.30	Ivoke et al., 2014
			-----	6.30 & 79.40	Bishop, 2017
			Feb 2016-Jan 2017	3.90	Nwachukwu et al., 2018
Ebonyi	Onicha	5.03	Aug 2005-Jul 2006	26.80	Uneke et al., 2006
				27.0	Elom et al., 2017
Ebonyi	Ishielu	4.93	Jan-March 2009	46.18	Ozowara et al., 2011
			-----	22.70	Onwe et al., 2016
Enugu	Nkanu East	6.12	-----	34.10	Bishop, 2017
				13.60	Aribodor et al., 2019

Anambra	Anambra west	4.64	Oct 2007-Sept 2008	12.80-19.80	Ugochukwu et al., 2013
			-----	2.90	Ndukwe et al., 2019
Benue	Gwer east	5.64	Nov 2008-Sept 2009	38.60	Houmsou et al., 2012
			Sept 2012	36.0-64.0	Amuta & Houmsou, 2014
			-----	41.50	Bishop, 2017
			-----	20.70	Emmanuel et al., 2017
			2013-2015	13.10	Amuga et al., 2020
Plateau	Jos north	5.70	-----	6.40	Dawet et al., 2012

An overall prevalence of 7.1% was obtained from a total of 5,514 urine samples. Similar to results published in previous studies (Otuneme, et al., 2014, Gbonhinbor & Abah., 2019), males were infected more than their female counterparts, although this result was not statistically significant. This could be as a result of a lack of differences in sociocultural behaviors between the two genders. In general, in most parts of south and central Nigeria, there are no gender-based cultural restrictions associated with the water bodies. Even though Ezeh, et al., (2019), reported that the females had a higher prevalence of the disease when compared to their male counterparts. Our study also revealed an increase in prevalence with respect to age among the primary school pupils (age group 12-14 years). This is consistent with the findings of Gbonhinbor & Abah., (2019), Amuga , et al., (2020), and may be attributed to the frequent water contact activities exhibited by pupils within this age group. In contrast, Angora et al., (2020) did not observe any difference in prevalence among the three age groups investigated in a study conducted on the Ivory Coast.

There was no significant association between the parents' educational status (except fathers' primary education) and occupation and the infection status. This could be attributed to the fact that collecting water from the stream may not be related to the profession of one's parents' or their societal status, but instead by activity in some rural areas. This result is in contrast to the findings of Ugbomoiko et al., (2010), which showed that parents with a higher level of education could better understand the preventive strategies and explain them to their children. Nonetheless, Geleta et al., (2015), Angora et al., (2019), showed that 'farmer' as parents' occupation was statistically significant to an increase frequency of the disease.

The relationship between the prevalence of schistosomiasis and contact with freshwater bodies infested with cercariae is well established (Ugbomoiko, et al., 2010, Gbonhinbor & Abah., 2019). In fact, and as expected, we found that frequent contact with freshwater bodies infested with cercariae, like contact when collecting water for domestic use, recreation, swimming, washing and fishing was associated with urogenital schistosomiasis. This is to some extent logical since bilharziasis is directly linked to the exposition of schistosomiasis contaminate freshwater.

S. haematobium and *S. mansoni* have been reported to be endemic in Nigeria, but the latter is less prevalent and widespread (Garba et al., 2004). A survey carried out in 2015 in 19 states of Nigeria showed the proportion of *S. haematobium* and *S. mansoni* as 82% to 18%, respectively. The overlapping distribution of the two species could increase the chance of co-infection and the potential severe effect on morbidity. There is cause for concern over the possible ongoing control challenges in these areas.

5. **Conclusions**

The result obtained in this survey shows that the disease is still endemic in the studied areas despite a significant increase in the praziquantel treatment coverage index. This presents a health hazard among the infected children who could play a leading role in the spread of the parasite. However, a decrease in the prevalence of the disease in most of the study areas when compared with results reported by previous studies, suggests that recent efforts to fight the disease seem to have yielded positive results. If these efforts are continued over a long period in combination with a long-term well-structured control approach, they are likely to result in elimination, at least in areas with lower transmission.

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