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RESEACH ARTICLE

SEX-ASSOCIATED PREVALENCE OF *PLASMODIUM* AND *SCHISTOSOMA* INFECTION AMONG SCHOOL CHILDREN AND RIVERINE COMMUNITIES OF MAKURDI, BENUE STATE-NIGERIA

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Abstract

Background: Malaria and schistosomiasis continue to be a big burden to infectious disease prevalence in the tropical areas, mainly in sub-Saharan African countries. **Materials and Methods:** This study determines the prevalence of *Plasmodium* and *Schistosoma* infection among riverine communities in Makurdi, Benue State, Nigeria. Blood, urine and stool samples from 720 participants were collected and examined. **Results:** The results showed that 242 (33.6%), 105 (14.6 %), and 47 (6.5%) of the participants were infected with *P. falciparum*, *Scistosoma haematobium*, and *S. mansoni* respectively. It was observed that *P. falciparum* had the highest prevalence among females 125 (17.4%), followed by *S. haematobium*81 (11.3%) females, the lowest prevalence was *S. mansoni* 38 (5.3%) in females. Sex-specific prevalence revealed that the highest prevalence of *P. falciparum* was among females 48 (20.0%) in Ankpa Wadata Ward, while the least prevalence among males 33 (13.8%) was recorded in North Bank II Ward. The highest prevalence among females 32 (13.3%) of *S. haematobium* was recorded in North Bank II Ward, while the lowest prevalence was among males, 7 (2.9%) in Ankpa Wadata Ward. The highest prevalence among females 25 (10.4%) of *S. mansoni* was recorded in North Bank II Ward, while the lowest prevalence among males and females 3 (1.3%) was observed in Ankpa Wadata Ward. **Conclusion:** There is no statistically significant difference (P > 0.05) in Prevalence of *P. falciparum* and *S. mansoni.* However, a statistically significant difference (P < 0.05) in prevalence of *S. haematobium* in the different riverine communities. It is important that health education be organized for the concerned communities.

Keywords: *Plasmodium, Schistosoma*, Sex, Riverine communities

Introduction

Malaria and schistosomiasis remain the causes of high morbidity and mortality in the tropics and sub-tropics of Africa (Doumbo*et al.*, 2014; Nwabueze, *et al.*, 2018). Malaria is a complex and life-threatening parasitic disease caused by the protozoan parasite of the genus *Plasmodium* (Getie*et al.*, 2015). Other species that affect humans include: *P. vivax*, *P. ovale* and *P. malariae.* Schistosomiasis is a chronic and debilitating disease caused by flukes (digenetic Trematode flatworms) known as *Schistosomes* (Okpala *et al.*, 2004).

Schistosomiasis ranks second only to malaria in terms of its socio-economic and public health importance in tropical and subtropical areas (Ogbe, 2002). It is also the most prevalent of the waterborne diseases and one of the greatest risks to health in rural areas of developing countries (Ogbe, 2002; Ofoezie *et al.*, 1998). An analysis, based on African studies, showed that there is a risk ratio of 2.4 and 2.6 for urinary schistosomiasis (caused by *S. hematobium*) and intestinal schistosomiasis (caused by *S. mansoni*), respectively, among persons living adjacent to reservoirs. Infection occurs through contact with water

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infested with the free-swimming larval stages of parasitic worms (cercariae) that penetrate the skin of humans. Parasite eggs leave the human body with urine or excreta. *Bulinus* snails are the intermediate host for *S. haematobium* (Okoli and Iwuala,2004). Within the snails, they develop into cercariae, which are, in turn, released into the water to infect new human hosts. Transmission can take place in almost any type of habitat from large lakes or rivers to small seasonal ponds or streams (WHO, 2001; Akue *et al.,* 2011). In urinary Schistosomiasis, the worms live in the blood vessels of the bladder with few eggs being excreted in the urine, while the rest stay in the body, thereby damaging other vital organs.

It is the eggs and not the worm itself which cause damage to the intestines, the bladder and other organs (Brooker *et al.*, 2007).

In Nigeria, Schistosomiasis due to *S. haematobium* is widespread, constituting a public health problem particularly in children (Sulyman*et al*., 2009 Okpala*et al*., 2004 and Griffiths *et al*., 2011). There are reports of Bilharziasis in Benue State (Amali, 1989; Atu and Galadima, 2003; Houmsou, *et al*., 2012), Four species of *Schistosomes* are responsible for human schistosomiasis (Swai*et al.*, 2006).

The prevalence of malaria-schistosomiasis co-infection was reported to be 15 % and caused high prevalence of anemia, as compared to those infected only with malaria (Degarege *et al.*, 2012). Both malaria and schistosomiasis are endemic in Nigeria (Terer *et al.*, 2013). Malaria environmental risk factors include: low utilization of nets, low utilization of indoor residual spray, and availability of multiple mosquitoes breeding site or stagnant water near the home and staying outdoor overnight. Schistosomiasis risk factors are: lack of access to safe water, contact or exposure to fresh water bodies, outdoor activities, low socio-economic status, and poor educational access (FMOH, 2007; Getie *et al.*, 2015).

MATERIALS AND METHODS

The Study Area

Makurdi lies between latitude 7.732152° 41° N and longitude 8.539144° 28° E (Fig. 1). The Benue River runs through Makurdi, and the city's primary settlements are around 671 meters long (Udo, 1981). The rainy season lasts seven months (April to October), with an annual rainfall of 120-200cm on average (Akaahan *et al.,* 2010). Agricultural activities, bathing, swimming, and washing in rivers and streams are common during rainy season (Houmsou *et al.*, 2012). Throughout the year, the area has high temperatures ranging from 28-33 ^{o}C, with the months of March and April being the hottest. During the months of December and January, the Harmattan winds are accompanied by cooling effects (Nyagba, 1995).

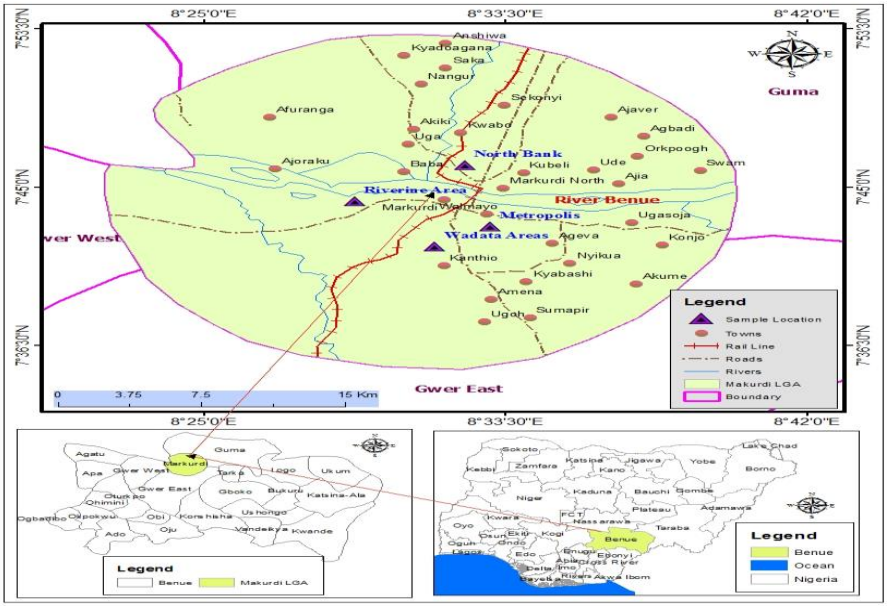

Figure 1: Map of Makurdi, Benue State. Source: Modified from Administrative Map of Benue State.

Sample Size Determination

The sample size (n) was estimated using modification formula ($n = Z^2(1-p)/L^2$) Kogi, (2015)

$$N = \frac{Z^2\,(1-p)}{2L^2}$$

Where:

n = is the sample size required.

Z = The normal distribution at 95% confidence interval

P = Proportion of infected individuals on a scale of 1

q = Proportion of infection free individuals on a scale of 1

L = Precision level or allowable error on a scale of 1

Ethical Considerations

Ethical approval was obtained from Benue State Ministry of Health with the reference number MOH/STA/204/VOL.1/124, the Federal Medical Centre with the reference number FMH/FMC/MED.108/VOL.1/X. Permission was also sought from Makurdi Local Government Education Authority, the Head of the Riverine Communities, and the parents of the selected children.

The Study Period

The study was conducted from June, 2020 to February, 2021. These months are characterized by rainy season especially from June to October, and harmattan/dry season which normally prevails from the month of November to February.

Study Design

A simple random sampling was utilized in the selection of the participants from each schools as well as from the riverine communities.

The Study Population

Seventeen (17) schools and three (3) riverine communities were randomly selected based on proximity to source of water.

Inclusion Criteria

Primary 1-3 and 4-6 pupils of age range 6–9 and 10-13 years respectively, and secondary school students of age range 14-17 and 18-21 years respectively were recruited. From the riverine communities, 1-10, 11-20, 21-30 and 31-40 years age groups were also recruited. The anonymity of each pupil was treated with high level of confidentiality as far as the purpose of this research is concerned.

Data Collection and Questionnaire Administration

The data was gathered from the respondents using a structured questionnaire. Socio-demographic data such as age, sex, parent's occupation (for school-aged children and children from the riverine communities), water source and water contact activities, method of water treatment, housing distance from the water body, outdoor activities, and other variables were all asked. With the help of health education workers, community-based research assistants, and teachers, some of the questions were translated to their native language for better understanding.

The students and riverine communities were also grouped into their respective classes and working places, as adopted by Kapito-Tembo *et al.* (2009).

Sample Collection and Laboratory Analysis of Samples

One thousand and sixty (1,060) blood, urine and stool samples were collected from each of the 1,060 individuals. The stool samples were collected in a clean, wide-mouthed, screw capped and dry transparent containers, sterile urine sampling bottles were used for urine samples, while anticoagulant blood sampling bottles (EDTA bottles) were used for blood samples (Cheesbrough, 2006; Mu'azu, 2008). Collection was done between the hours of 07am – 10am and the samples were transported to the laboratory of the Federal Medical Centre Makurdi for analysis according to the method given by Cheesbrough (2005).

Microscopic Assessment of *Plasmodium* Species

Two drops of venous blood were placed separately on a microscopic glass slide as adopted by WHO (1991) and Nyarko *et al*. (2018) Thick and thin blood films were

prepared and air dried. The thin blood films were fixed with absolute methanol and both films were stained with 10% Giemsa stain for 10 minutes. Both the thin and the thick blood films were examined using a light-camera microscope (LEICA DM 2500 model) with a ×100 objective lens for the presence of malaria parasite.

$$\text{Parasites per microliter} = \frac{\text{Number of parasites counted}}{\text{Number of leukocytes (WBCs)}} \times 8000$$

Analyses of Urine Samples for Schistosomiasis Detection

The chemical reagent strip methods as described by Cheesbrough (2002); WHO (2011) were utilized for the examination of haematuria. Reagent strip combi-9 and combi-10 (Medi-Test Macherey-Nagel, Germany) was dipped into each urine sample and the color was matched with the standard color by the side of the container, as recommended by the manufacturer to determine the presence of blood in urine. The urine samples were examined to detect the presence of eggs using sedimentation technique.

Analyses of Stool Samples for Schistosomiasis

Using the standard Kato-Katz technique adopted by WHO (1991); WHO, 2011; Solomon *et al.*, (2013), Rasoamanamihaja*et al*. (2016) and Feleke*et al.* (2017), about 1–2 mg of the stool sample was emulsified in a drop of normal saline (0.85 % NaCl) on the center of the slide using a disinfected stick.

Presence of lateral spine indicates *S. mansoni.* The procedures developed by WHO (2011) were used to determine the intensity of the *S. mansoni*i nfection. Two slides per individual stool sample were prepared by filling a Kato-Katz template on two separate slides with stool (Kato-Katz kit, Vestergaard-Frandsen, Lausanne, Switzerland), levelling and covering each sample with a cellophane slip pre-stained with methylene blue (Katz *et al.,*1972**).**

Data Analyses

Descriptive statistics was used to determine the frequency of distribution and percentage of the prevalence of *Plasmodium* and *Schistosoma* species. Chi-Square was used to test the association of *Plasmodium* and *Schistosom a*species with demographic and socio-economic factors.

Odds ratio was used to test association between risk factors and prevalence of infection and one-way ANOVA. Values were also considered to be significant at $P < 0.05$.

RESULTS AND DISCUSSION

Table 1 revealed sex-associated prevalence of *Plasmodium* and *Schistosoma* species among the riverine communities in Makurdi, Benue State, Nigeria. This result shows that *P. falciparum* had the highest prevalence among females 125 (17.4%), followed by *S. haematobium* 81 (11.3%) females which corroborates with the findings of Alhaji *et. al.* (2021) in Warwade community. The least prevalent was *S. mansoni* 38 (5.3%) females. Sex-specific prevalence revealed that the highest prevalence among females 48 (20.0%) of *P. falciparum* was recorded in Ankpa Wadata Ward, while the lowest prevalence among males 33 (13.8%) was recorded in North Bank II Ward. The highest prevalence among females 32 (13.3%) of *S. haematobium* was recorded in North Bank II Ward, while the lowest prevalence among males 7 (2.9%) was recorded in Ankpa Wadata Ward.

The highest prevalence among females 25 (10.4%) of *S. mansoni* was recorded in North Bank II Ward which corroborates the findings of Samuels *et. al.* (2012), while the lowest prevalence among males and females 3 (1.3%) each was recorded in Ankpa Wadata Ward. There is no statistically significant difference ($P > 0.05$) in prevalence of *P. falciparum* and *S. mansoni.* There is a statistically significant difference ($P < 0.05$) in prevalence of *S. haematobium* in the different riverine communities.

Out of the total number of 180 samples of the nine (9) secondary school students examined, male and female have the following prevalence: Forward Ever Academy Wadata male students have 3 (15.00%), female 3 (15.00%) *Plasmodium falciparum,* male 1 (5.00%), female 2 (10.00%) *Schistosoma haematobium* and male 1 (5.00%), female 0 (0.00%) *Schistosoma mansoni* respectively. Extensive College Wadata male students 4 (20.00%), female 6 (30.00%) *P. falciparum,* male 2

(10.00%), female 2(10.00%) *S. haematobium and* male 1(20.00%), female 0(0.00%) *S. mansoni* respectively. Salim Progress School Wadata male students 2(10.00%), female 4(20.00%) *P. falciparum*, male 1(5.00%), female 2(10.00%) *S. haematobium* and male 1(5.00%), female 0(0.00%) *S. mansoni* respectively (Table 2).

Al-Burhan International Academy Wadata has male 6 (30.00%), female 1 (5.00%) *P. falciparum*, male 5 (25.00%), female 4 (20.00%) *S. haematobium*, and male 2(10.00%), female 1(5.00%) *S. mansoni* respectively. Salam Academy Wadata male 1 (5.00%), female 5 (25.00%) *P. falciparum*, male 2 (10.00%), female 0(00.00%), *S. haematobium*, and male 1(5.00%)female 0(0.00%)*S. mansoni* respectively. Al-Irshad Model Academy Makurdi male 7 (35.00%), female 4 (20.00%), *p. falciparum*, male 6 (30.00%), female 0 (0.00%), *S. haematobium*, and male 3 (15.00%), female 0 (0.00%), *S. mansoni* respectively. Government Girls' College Makurdi male 0 (0.00%), female 10 (50.00%), *P. falciparum*, male 0 (0.00%), female 9 (45.00%), *S. haematobium*, and male 0 (0.00%) female 3 (15.00%), *S. mansoni* respectively.

Government College Makurdi male 7 (35.00%), female 0 (0.00%), *P. falciparum*, male 7 (35.00%), female 0(0.00%) *S. haematobium* and male 3 (15.00%), female 0 (0.00%) *S. mansoni* respectively. Aliyu Jama'a Memorial Arabic College Makurdi male 4 (20.00%), female 3 (15.00%), *P. falciparum*, male 0 (0.00%), female 3 (15.00%) *S. haematobium* and male 1 (5.00%), female 1 (1.00%) *S. mansoni* respectively. Table 4 shows the sex-specific prevalence of *Plasmodium* and *Schistosoma* species among secondary schools in Makurdi, Benue State, Nigeria.

The overall prevalence of *Plasmodium* and *Schistosoma* species of male and female of the 180 samples of nine (9) secondary school students examined are as follows: Male 93 (18.89%), female 87 (20.00%) *Plasmodium falciparum*, male 93 (13.33%), female 87 (12.22%) *Schistosoma haematobium* and male 93 (7.22%), female 87 (2.78%) *Schistosoma mansoni* respectively (Table 3). As such, with respect to males in primary and secondary school and females in primary and secondary, they have the following P-values: For *P. falciparum*, there is no significant difference between males in primary and secondary school as the P-value ($P = 0.62$) is > 0.05, and there is also no significant difference between males in primary and secondary school with respect to *S. haematobium* as the P-value ($P = 0.41$) is less than 0.05. Similarly, there is also no significant difference between males in primary and secondary school with respect to *S. mansoni* as the P-value ($P = 0.59$) is > 0.05. With regards to females in primary and secondary school, there is no significant difference in *P. falciparum* as the P-value ($P = 0.83$) is > 0.05, in *S. haematobium* as the P-value ($P = 0.61$) is > 0.05, and in *S. mansoni* as the P-value ($P = 0.86$) is > 0.05.

CONCLUSION

The prevalence of *Plasmodium falciparum, Schistosoma haematobium* and *Schistosoma mansoni* among the riverine communities in Makurdi, Benue State, Nigeria is sex-associated, with female 16 (33.3%), female 13 (27.1%) and female 15 (40.5%) respectively. In the primary school, the male have the higher prevalence of *Plasmodium falciparum* (21.88%), *Schistosoma haematobium* (20.00%) and *Schistosoma mansoni* (8.75%) compared to the female pupils. A similar result was presented in the secondary schools, except for *P. falciparum* infection, in which the female pupils have the higher prevalence (20.00%) than their male counterparts with prevalence of (18.89%).

Additionally, the infected individuals were treated with praziquantel, an anti schistosomal drug which is used for the treatment of schistosomiasis. Also, those with malaria were treated with arthemeter and lumfathrin.

Table 1: Sex-Specific Prevalence of *Plasmodium* and *Schistosoma* Species among the Riverine Communities in Makurdi, Benue State, Nigeria

		Plasmodium falciparum		***Schistosoma haematobium***		***Schistosoma mansoni***	
Riverine communities	**Number examined**	**Male (%)**	**Female (%)**	**Male (%)**	**Female (%)**	**Male (%)**	**Female (%)**
Ankpa Wadada Ward	240	37 (15.4)	48 (20.0)	7 (2.9)	27 (11.3)	3 (1.3)	3 (1.3)
Clerk/Market Ward	240	47 (19.6)	39 (16.3)	15 (6.3)	22 (9.2)	7 (2.9)	10 (4.2)
North Bank II Ward	240	33 (13.8)	38 (15.8)	9 (3.8)	32 (13.3)	7 (2.9)	25 (10.4)
Total	**720**	**117 (16.3)**	**125 (17.4)**	**31 (4.3)**	**81 (11.3)**	**17 (2.4)**	**38 (5.3)**
t-test P-value		**P = 0.64**		**P = 0.01**		**P = 0.35**	

Table 2: Sex-Specific Prevalence of *Plasmodium* and *Schistosoma* Species among Primary Schools Pupils in Makurdi, Benue State, Nigeria

Schools	**Number examined**	***Plasmodium falciparum***		***Schistosoma haematobium***		***Schistosoma mansoni***	
		Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)
CAC wad Prim. Sch.	20	7 (35.00)	4 (20.00)	6 (30.00)	0 (0.00)	3 (15.00)	0 (0.00)
Holy goht Prim. Sch.	20	7 (35.00)	2 (10.00)	11 (55.00)	3 (15.00)	4 (20.00)	1 (5.00)
LGEA ghr Prim. Sch.	20	5 (25.00)	5 (25.00)	6 (30.00)	3 (15.00)	2 (10.00)	1 (5.00)
Arabic ghr prim. Sch.	20	6 (30.00)	1 (5.00)	5 (25.00)	2 (10.00)	2 (10.00)	1 (5.00)
Root Succ Prim. Sch.	20	4 (20.00)	4 (20.00)	0 (0.00)	3 (15.00)	1 (5.00)	1 (5.00)
NomadicN prim.Sch.	20	2 (10.00)	4 (20.00)	2 (10.00)	2 (10.00)	1 (5.00)	0 (0.00)
LGEANB prim. Sch.	20	1 (5.00)	5 (25.00)	2 (10.00)	0 (0.00)	1 (5.00)	0 (0.00)
Al-ihsan I Prim. Sch.	20	3 (15.00)	5 (25.00)	0 (0.00)	2 (10.00)	0 (0.00)	1 (5.00)
Total	**160**	**35 (21.88)**	**30 (18.75)**	**32 (20.00)**	**15 (9.38)**	**14 (8.75)**	**5 (3.13)**
		P = 0.52		**P = 0.15**		**P = 0.04**	

Table 3:Sex-Specific Prevalence of *Plasmodium* and *Schistosoma* Species among Secondary Schools Students in Makurdi, Benue State, Nigeria

Schools	**Number examined**	***Plasmodium falciparum***		***Schistosoma haematobium***		***Schistosoma mansoni***	
		Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)
Forward Ever Academy	20	3 (15.00)	3 (15.00)	1 (5.00)	2 (10.00)	1 (5.00)	0 (0.00)
Extensive College	20	4 (20.00)	6 (30.00)	2 (10.00)	2 (10.00)	1 (5.00)	0 (0.00)
Salim Progress. S	20	2 (10.00)	4 (20.00)	1 (5.00)	2 (10.00)	1 (5.00)	0 (0.00)
Al-Burhan I Academy	20	6 (30.00)	1 (5.00)	5 (25.00)	4 (20.00)	2 (10.00)	1 (5.00)
Salam Academy	20	1 (5.00)	5 (25.00)	2 (10.00)	0 (0.00)	1 (5.00)	0 (0.00)
Al-Irshad Model	20	7 (35.00)	4 (20.00)	6 (30.00)	0 (0.00)	3 (15.00)	0 (0.00)
Gov't. Girls College	20	0 (0.00)	10 (50.00)	0 (0.00)	9 (45.00)	0 (0.00)	3 (15.00)
Gov't. College.	20	7 (35.00)	0 (0.00)	7 (35.00)	0 (0.00)	3 (15.00)	0 (0.00)
Aliyu Jama'a M	20	4 (20.00)	3 (15.00)	0 (0.00)	3 (15.00)	1 (5.00)	1 (5.00)
Total	**180**	**34 (18.89)**	**36 (20.00)**	**24 (13.33)**	**22 (12.22)**	**13 (7.22)**	**5 (2.78)**
		P = 0.87		**P = 0.87**		**P = 0.08**	

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Authors' Contributions:
IIM; Conceptualization, execution, drafting of manuscript. SGJ; Conceptualization, execution; ASA: data analyses, interpretation, and manuscript revision, BJB; data analyses and manuscript revision

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