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Prevalence of Schistosoma Infections among Residents along River Niger, Lokoja, Kogi State, Nigeria

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ABSTRACT:A cross sectional study was conducted to determine the prevalence of schistosomiasis among individuals living along the coast of river Niger, in Lokoja, Kogi State, Nigeria. Stool and urine samples were collected from 463 residents across the three study sites (Kpata, Adankolo and Ganaja) in Lokoja, with 165 (35.6%) individuals were found to be infected. *Schistosoma haematobium* and *Schistosoma mansoni* were detected in urine and stool samples respectively, using sedimentation techniques. The results showed that individuals within the age range of 13-17 years 106 (64.2%) had a higher prevalence as compared to individuals within the age range of 18-50 years 59 (35.7%). The results also showed statistical significance (P < 0.05) within sex groups with higher infection rate in females 98 (59.8%) as compared to their male 67 (40.6%) counterparts. Participants who had no formal education 108 (65.4%) pooled the highest prevalence for both *S. mansoni* and *S. haematobium* infections, while least infection was observed in participants with tertiary education 7 (4.2%). Statistical analysis revealed no significant differences (p>0.05) in infection rate between the study sites. The results of occupational status revealed highest prevalence in fishermen 52 (31.5%), and the lowest prevalence was recorded in student (7.8%). Statistically significant differences (p<0.05) were observed among the participants in the study area with respect to their proximity to the contaminated water sources. Participants <50m 305 (65.8%) prove to have highest prevalence of infection in the study area. The study concluded that schistosomiasis is prevalent in the study area. Thus, need for health education programmes on the danger of open defecation around water bodies, bathing, farming and drinking from such contaminated water sources in the areas, as well as urgent mass treatment with praziquantel and mass treatment of water sources with molluscides should be considered paramount. Public toilets and other basic amenities need to be provided for the people living in the study area.

Keywords: Prevalence, *Schistosoma haematobium*, *Schistosoma mansoni*, neglected tropical diseases; Schistosomiasis

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INTRODUCTION

Schistosomiasis or bilharzia is a neglected tropical disease caused by worms of the genus *Schistosoma.* It is associated with significant morbidity and mortality in many developing countries like Nigeria. Schistosomiasis remains major public health threat with significant socioeconomic impact in areas where control efforts and sanitation are inadequate and where majority of populations are impoverished (Hajissa *et al*., 2018). The transmission cycle requires contamination of surface water by excreta, specific freshwater snails as intermediate hosts, and human water contact. The main disease causing species are *S. haematobium, S. mansoni, and S. japonicum.* According to WHO (2012), 200 million people are infected worldwide, leading to the loss of 1.53 million disability-adjusted life years. Adult schistosomes reside in human (the definitive host) blood vessels surrounding the intestines or bladder and shed eggs that escape the body via urine or feces. If those eggs contact fresh water, they hatch as miracidia that must locate, penetrate and infect aquatic snails (intermediate host). The parasite reproduces asexually in its snail host, shedding free-swimming cercariae as many as 2,000 or more per snail, per day, usually for the remaining life of the infected snail. Cercariae infect humans via skin penetration when they walk, bathe, or swim in infested freshwater, lakes, ponds, streams, and irrigation canals. Schistosomiasis can cause mild to severe infections (Amawulu and Ndubuisi, 2021).

However, anthropogenic sources around river Niger are quite high; majority of the residents lack basic sanitary measures and access to clean water as a result, the influx of pollutants into the aquatic environment may increase the prevalence of parasitic infections thereby making the environmental condition fit for parasite survival. Praziquantel has been reported to be a safe and effective treatment, and this approach is said to significantly reduce the prevalence of schistosomiasis and the intensity of infection in high prevalent areas, Arostegui *et al*. (2019). However, three major limitations characterized this approach including high re-infection rates, unsustainable mapping and delivery with its high dependency on donations of praziquantel, and exclusion of other high-risk groups such as people who frequently have contact with water for domestic and professional purposes. Therefore, there is a need for constant surveillance and effective monitoring to determine the current infection status and geographical overlap between the two species of schistosoma. Hence, this research focuses on the current prevalence and risk factors assessment of schistosomiasis in Lokoja, Kogi State, Nigeria.

MATERIALS AND METHODS

The study was conducted in Lokoja, which is the capital of Kogi State. Lokoja lies at the confluence of the Niger and Benue rivers and it is located in the middle belt region of Nigeria, of Latitude: 7° 48' 8.352'' N and Longitude: 6° 44' 0.0348'' E of the equator. It is often referred to as the confluence city (Patrick and Umar, 2019). River Niger covers about 3180 km. The major occupation of residents especially those along the Niger River Basin is fishing and farming. Irrigated fields of vegetables and staple crops such as maize, cover the entire length of the river Basin. However, human settlement around river Niger has continued to be on the increase over the years and sprang up lots of anthropogenic activities which have led to shortage of decent accommodation for inhabitants. This could largely be responsible for the reason why a substantial proportion of residents in Lokoja live in slum areas along the river valley, lacking basic sanitary facilities. Thus, defecation on farm lands and behind dense vegetation has become a popular practice and these conditions are predisposing factors to many parasitic infections and their intermediate hosts (Figure 1).

Study design

The study was carried out from November 2021 to May 2022. This cross-sectional survey involved sample collection from residents of Kpata, Adankolo and Ganaja within the age groups of 13 to 50 years; adolescent and adults. In each study community, simple random sampling was carried out to select participants.

Ethical consent

Ethical permission was obtained from Kogi State Ministry of Health Ethical Board in Lokoja. Advocacy visits were carried out to residents of the study areas selected prior to the commencement of the study. Informed consent was gotten from community heads and leaders of the study areas. Approval was also gotten from community heads and registered participants for sample collection. Those who were unable to produce fecal and urine samples were excluded from the research.

Determination of risk factors

Questionnaire and physical observation were utilized to determine the risk factors associated with the transmission of schistosoma infections in the study sites.

Sample size determination

Sample size was estimated using the formula below:

$$n = \frac{Z^2 \times P\,(1-p)}{E^2}$$

Where Z= 95% Confidence Interval

P= Prevalence of S*chistosoma haematobium* and *S. mansoni* infections.

E= Error rate = 0.05(5%).
n= 500 + 20% non-respondents' value
n= 500+ 100
n= 600

However, for this study, 600 participants were consulted, but 463 respondents were actively involved across the study areas.

Sampling procedure

A total of 463 stool and urine samples of participants within the study areas were randomly sampled and examined for *S. mansoni* and *S. haematobium* respectively. The participants were within ages 13 to 50 years. All the participants selected were categorized according to age, sex, gender, educational and

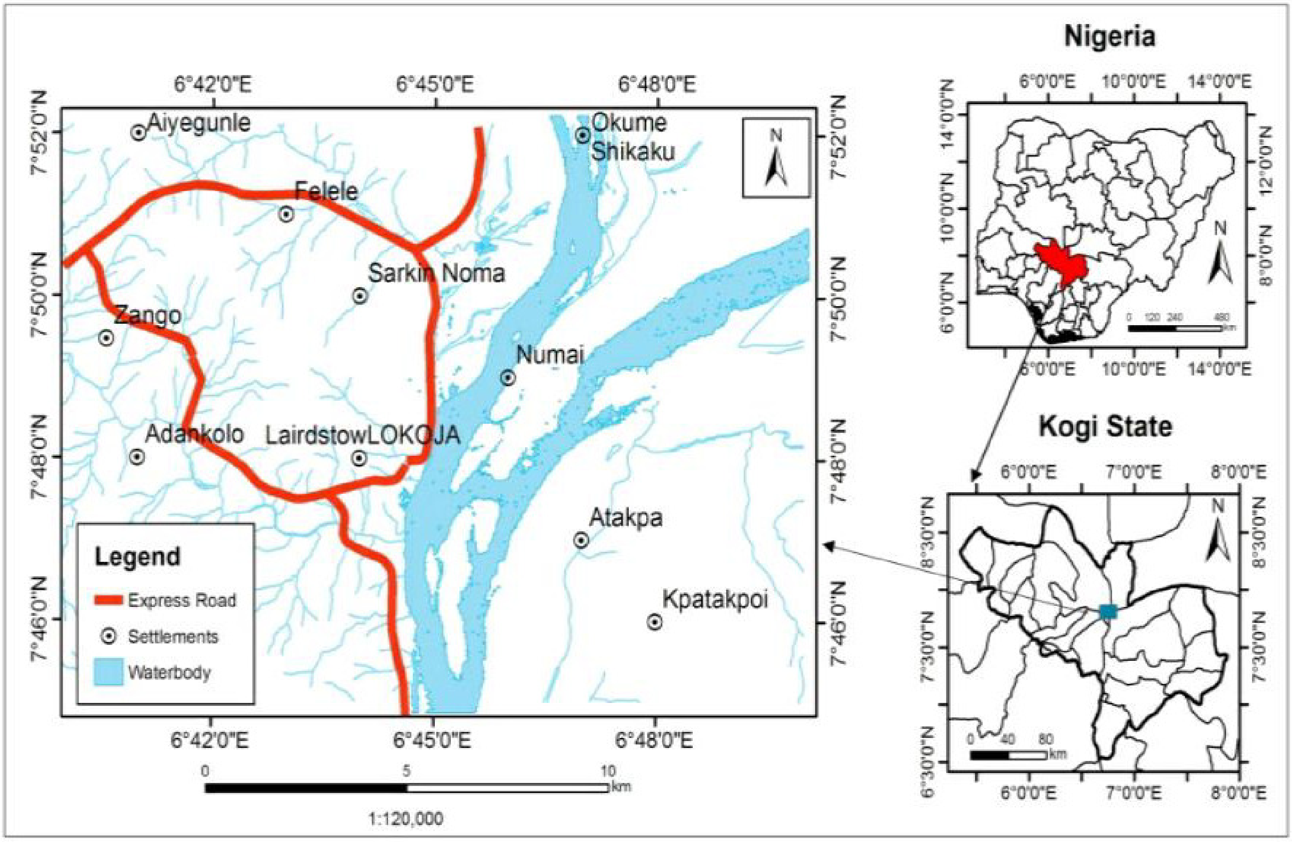

Figure 1: Map of study area (Patrick and Umar, 2019).

occupational status. The participants were provided with sterile bottles that were carefully labelled with individual names clearly written. Each participant was instructed to collect stool and urine samples early hours in the morning. The samples collected from participants were brought to the laboratory for parasitological examinations.

Physical observation

Careful visual inspection of each collected urine sample was performed to identify possible color deviations from the color of a normal urine sample taken from a healthy person. The purpose of this process was to detect both macro and micro hematuria. The physical appearance of each stool sample in terms of color, such as brown, bloody and cloudy, was carefully observed and recorded (Verani *et al.*, 2011).

Urine microscopic examination

A few drops of Sodium Chloride were introduced to each urine sample and 10ml of the samples were transferred to a centrifuge tube each and spun at 2000 rpm for 1 minutes. The supernatant was then decanted and then the residue was mixed by tapping the bottom of the centrifuge tube. Thereafter, a drop of the deposit was introduced on a clean glass slide using a dropper. The slide was covered with a cover slip, to avoid air bubbles and then mounted on the microscope stage and viewed using X 40 objective lens.

Stool microscopic examination

The collected stool samples were fixed in 10% formalin for 30 minutes. Thereafter, the solution was filtered and 10ml of normal saline was introduced and mixed well. This was centrifuged for 2 minutes at 2000 rpm. The supernatant was discarded and the sediment was left in the tube. 9ml of 10% formalin was introduced into the tube containing the sediment. Then, 3ml of ethyl acetate was introduced to the tube and capped. The solution was wobbled well for 30 seconds and centrifuged for 1minutes at 2000rpm. Thereafter, the supernatant was decanted and the sediments in the test tube was smeared thinly on a clean glass slide, two drops of iodine solution were

Table 1: Socio-demographic status of residents in the study area.

Variables	No. Participants	Percentage (%)
Study sites		
Kpata	193	41.6
Adankolo	150	32.3
Ganaja	120	25.9
Total	463	100%
Age group		
13-17	183	39.5
18-50	280	60.4
Occupational Status		
Fishermen	136	29.4
Farmers	113	24.4
Boat riders	67	14.4
Traders	112	24.2
Students	36	7.7
Educational status		
Primary	114	24.6
Secondary	99	21.4
Tertiary	45	9.7
No formal education	205	44.3
Sex		
Male	205	44.2
Female	258	55.7

introduced onto the slide, covered with a cover slip and mounted on the microscope stage and viewed using X10 and X40 objective lenses.

RESULTS

Socio-demographics of residents

A summary of respondents in relation to study sites, age, occupational status, educational status and sex was recorded (Table 1). A total of 463 samples were collected and analyzed for schistosomiasis. The characteristics of the study participants were also recorded. The communities where the samples were collected includes: Kpata (n=193), Adankolo (n=150) and Ganaja (n= 120). The age range of the study participant was (13-50). Out of the 463 participants, 205 (44.2%) were males and 258 (55.7%) were females.

The majority 280 (60.4%) of the participants were of the age range of 18- 50 years. Out of the total participants, fishermen136 (29.4%) had the highest number of participants studied, followed by farmers 113 (24.4%). Students proved to be the least participants during the study.

The educational status of the study areas showed persons with no formal education prove to have the highest percentage 205 (44.3%), followed by Primary 114 (24.6%) and secondary 99 (21.4%). The least number of participants were the tertiary group with 45 (9.7%) as indicated (Table 1).

Prevalence of schistosoma infections amongst residents of the study areas

Site specific prevalence

The prevalence of schistosoma infection in relation to study sites, age groups, sex, educational status and occupational groups of participants was recorded (Table 2). A total of 165 samples were positive for schistosoma infection out of the 463 samples analyzed. The result recorded higher infection in Kpata 90 (54.5%), followed by Adankolo with 45 (27.2%) positive cases and the least prevalence was recorded in Ganaja with 30 (18.1%). The result of the study sites showed statistically significant ($P<0.05$) among the three study areas.

Age specific prevalence

The differences in the prevalence of schistosoma infection among the two-age group considered during the study period was also depicted (Table 2). Group 13-17 years recorded highest prevalence 106 (64.2 %) while group 18-50 years recorded the lowest 59 (35.7%) infection rate. There was a statistically significant difference ($P<0.05$) among the two age groups.

Sex specific prevalence

The result of the sexes that participated in the study shows high infection rate in females with 98 (59.8%) as compared with the male 67 (40.6%) counterparts. Statistical comparison revealed significant difference between the two sexes ($P<0.05$).

Educational status-specific prevalence

The outcome of schistosoma infection in relation to educational status of the participants revealed highest prevalence in individuals with no formal education 108 (65.4%), followed by individuals who has primary education 28 (16.9%), and secondary education 17 (10.3%). The least prevalence was observed in participants with tertiary education 7 (4.2%) (Table 2). In general, the infection rate among the different educational group showed no statistical significance ($P>0.05$).

Occupational specific prevalence

The result of the different occupational groups of the participants showed that the highest prevalence of the different occupational group was recorded in fishermen (31.5%), followed by farmers 43 (26.0%), boat riders 32 (19.3%), traders 25 (15.1%). The lowest infection rate was recorded among students 13 (7.8%). The overall result of the occupational groups showed there was

Table 2: Prevalence of Schistosoma infections in relation to study areas, age groups, educational status and occupational status.

Variables	No. of positive	F. cal.	p. value	F. crit
Study areas				
Kpata (193)	90 (54.5)	1.16209774	0.374479*	5.143253
Adankolo (150)	45 (27.2)			
Ganaja (120)	30 (18.1)			
Total (463)	165 (35.6)			
Ag groups				
13-17	106 (64.2)	8.276757	0.00401*	_
18-50	59 (35.7)			
Total (463)	165 (35.6)			
Sex				
Male	67 (40.6)	2.095893	0.147695*	_
Female	98 (59.8)			
Total	165 (35.6)			
Educaional status				
Primary	28 (16.9)	0.435927	0.611233	5.1432
Secondary	17 (10.3)			
Tertiary	7 (4.2)			
No formal Edu.	108 (65.4)			
Total	165 (35.6)			
Occupational status				
Fishermen	52 (31.5)	10.17193	0.0049*	4.256495
Farmers	43 (26.0)			
Boat riders	32 (19.3)			
Traders	25 (15.1)			
Students	13 (7.8)			
Total	165 (35.6)			

*Significant at P< 0.05

Table 3: Risk factors associated with the transmission of schistosoma infections in Lokoja, Kogi State, Nigeria.

Categories	No. Examined (%)	F. cal.	P. value	F. crit
Defecation and urination practice				
Bush	180 (38.8)	0.491138	0.65386	9.552094
Pit toilet	170 (36.7)			
Water closet	113 (24.4)			
Proximity of the river				
<50 m	305 (65.8)	7.24049	0.0267*	
>50 m	158 (34.1)			
Frequency of water contact				
Hourly	195 (42.1)	0.283103	0.762975	5.143253
Daily	150 (32.3)			
Weekly	75 (16.1)			
Monthly	43 (9.2)			

*Significant at P<0.05.

significant difference within the participants (P<0.05) (Table 2).

Risk factors associated with schistosoma infections

The risk factors that predispose of the participants in the study areas to schistosoma infections were determined (Table 3). The risk factors included: improper waste disposal such as open defecation and urination practices, proximity of the participants to the contaminated waters and frequency of water contact. The results of the study depict strong relationship between the high prevalence rate of schistosoma infection and the risk factors. Therefore, out of 463 individuals, a greater percentage

Table 4: Prevalence of *S. haematobium, S. mansoni* and mixed infection.

Study areas	*S. haematobium*	*S. mansoni*	Mixed	Total	F	P. value	F. crit
Kpata (193)	55(33.3)	30(18.1)	5(3.0)	90(54.5)	4.49356	0.1252*	9.55209
Adankolo (150)	30(18.1)	12(7.2)	3(1.8)	45(27.2)			
Ganaja (120)	15(9.0)	10(6.0)	5(3.0)	30(18.1)			
Total (463)	100(60.6)	52(31.5)	13(7.8)	165(35.6)			

*Significant at P<0.05

180 (38.8%) of participants across the study sites practice open defecation and urination in the bush. Participants who utilize pit toilet was 170 (36.7%) and 113 (24.4%) of participants utilize water closet. The result showed no significant difference (P>0.05). However, the proximity of participants was categorized into two groups in this study. Those whose distance was <50 m had the highest participants 305 (65.8%) who were at greater risk of having infection, compared to those whose proximity was >50 m 158 (34.1%). This showed astatistical significant difference (P<0.05). It also showed the frequency of water contact among participants of the study sites, which was grouped into four categories; hourly, daily, weekly and monthly. Participants whose contact was hourly recorded 195 (42.1%), followed by daily group 150 (32.3%), weekly group recorded 75 (16.1%) participants and 43 (9.2%) for the monthly group. The result shows no statistical differences (P>0.05) within the four groups.

Prevalence of *S. haematobium, S. mansoni* and mixed infections

The prevalence rate of the different species of schistosoma infections among the participants in the three study areas was calculated (Table 4). The result recorded highest prevalence of *S. haematobium* infection (33.3%, 18.1% and 9.0%) as observed in Kpata, Adankolo and Ganaja respectively, compared to the prevalence of *S. mansoni* infections (18.1%, 7.2% and 6.0%) among participants of Kpata, Adankolo and Ganaja respectively. Mixed infections recorded high prevalence in Kpata and Ganaja with 3% each and the lowest prevalence was seen in Ganaja with 1.8% of positive cases. The results showed statistically significant difference (p<0.05) between the two species prevalent in the study area (Table 4).

DISCUSSION

This study examined the transmission of both urinary and intestinal schistosomiasis in Lokoja, Kogi State, Nigeria. The sites were chosen from preliminary investigations of human to water contact. The study revealed that both urinary and intestinal schistosomiasis is still prevalent in Lokoja, Kogi State, Nigeria. A higher prevalence of *S. haematobium* and *S. mansoni* (60.6% and 31.5%) infection was reported amongst participants in the study sites. This is in agreement with the reports of urogenital schistosomiasis observed among fishermen in Tanzania by Mangara *et al*. (2022) and prevalence of *S. mansoni* infection in rural communities in Ethiopia (Tazebew *et al*., 2022). Both studies contradict the findings of Opara*et al*. (2021) in Cross River State who reported a low prevalence rate of schistosoma infections. The high prevalence of infections in previous findings and the variations in prevalence among participants of the study sites might be due to differences in environmental conditions, sanitation, and personal hygiene. In the present study, the age group 13-17 years recorded the highest prevalence of 106 (64.2%) years recorded the highest prevalence rate which agrees with the reports of Gruninger *et al*. (2023) and higher than 21.7% reported by Opara *et al*. (2021) and (9.9%) Yousif and Elawad, (2022).This is because this age range are most active groups that are involved in outdoor activities such as fetching water from streams and rivers, swimming in contaminated water bodies, farming, playing and walking barefooted and poor personal hygiene. Also, this age group eat indiscriminately with unwashed hands.

Several studies have observed that schistosomiasis affects males more than females (Yousif *et al*., 2022; Opara*et al*., 2021 and Gruninger *et al*., 2023). However, the result of this study revealed that females had higher prevalence than males, which was statistically significant due to the fact that females were active in outdoor activities than their male counterparts, thus leading to more positive cases in females. Additionally, domestic and commercial activities (Washing, smoking of fish and trading) carried out at the bank of the river by females played a major role in this regard. This finding is similar to the work of Otuneme *et al*. (2019) who reported that female participants had more prevalence for schistosoma infections due to water contact activities. In the present study, higher prevalence of schistosoma infections was recorded in occupational status of individuals (fishermen, farmers and traders) who had close contact with river Niger waters. This is in-line with the work of Ismail *et al*., (2022) who observed that schistosomiasis is a disease of impoverished individuals and farmers due to persistent water contact activities for irrigation, fishing and due to lack of personal hygiene. Similarly, Otuneme *et al*., (2019) found out that most of the occupational activities like farming practices increase the intensity of infections directly. Also, residents close to water bodies practice open defecation at river banks due to lack of sanitary systems (Pukuma *et al*., 2007).

Educational status in this study showed that participants with no formal education had the highest prevalence than their counterparts (primary, secondary and tertiary) groups which showed no statistical significance (P>0.05) and indicates lack of awareness or basic information about the disease across all groups of educational status (Essa*et al*., 2013). From the result, this was part of the problem that increased the persistent water contact activities and this may also, increase the severity of infections and decrease the interest of people from seeking medical treatment. This agrees with the findings of Liu *et al*. (2022); Li *et al*. (2019) and Abdulkadir and Ali, (2020).

The research showed open defecation and urination in bush (38.8%) as the highest risk factors associated with the endemicity of schistosoma infections in the study sites. Bush practices were common amongst participants of the three study areas. This is due to impoverished status of participants who lack access to basic sanitary facilities. This however agrees with the documentation of Dawaki *et al*. (2015); Pukuma *et al*. (2007).

The proximity of residents to fresh water bodies have always been a major influence on the environment. This is because; irrigation practice, transportation and trade are carried out at the bank of waterbodies which exposes humans to floods and waterborne diseases. However, the proximity of participants to the contaminated water sources in the study area also displayed a risk factor to infections as groups of participants whose proximity was <50m showed greater risk across the study sites with a higher prevalence of 65.8% of respondents utilize the freshwater for various purpose (trading, farming, fishing, washing, bathing and open defecation) which makes them exposed to infections. This shows that more water contact activities increase the prevalence of infections which is similar to the reports made by Lamberti *et al*. (2021). However, Distance of water contact greater than 50m was relatively low across the study areas as higher percentage of residents were closer than farther and this may decrease the prevalence of infection as this group of participants utilize other sources of water which may not expose them to risk of having infections. This is in agreement with the findings of Li *et al*. (2019). The magnitude of water contact frequency by humans is an influential risk factor of parasitic infection as well as waterborne diseases. Hence, the frequency of water contact by participants in this study was observed to be much higher hourly (42.1%), which sets the participants at greater risk of having infections. This indicates persistent closeness to the fresh water due to a lot of activities been carried out and thus, increases the intensity of infection amongst residents. This is similar to the work reported by (Akinboye *et al*., 2011), who explained that the frequency of water contact is persistent to residents close to water bodies, than a those who are not close to infested water bodies. This phenomenon enhances a lot of anthropogenic activities and also, increases the intensity of infections as residents get exposed often to schistosoma infections (Oso and Odaibo, 2020).

The results of the prevalence rate of *Schistosoma haematobium* and *mansoni* from this study shows that both infections are still prevalent, in Lokoja. Both infections shows that the community lacks the capacity to change their behaviour, owing to the fact that their alternative source of water have not been functional for few years. In view of these, they utilize the fresh water as the main source of water; hence, it has sprung up anthropogenic activities along the bank of the river. This indicates low level of awareness and public enlightenment about the disease. Basically, the increase in infection is associated with the residential area and people's attitude to the environment (Angora *et al*., 2019; Dawaki *et al*., 2015). Similarly, *S. haematobium* infections and *S. mansoni* infections were more prevalent with *S. haematobium* having a higher prevalence (60.6%) than *S. mansoni* (31.5%) in this research, which was statistically significant. This observation could be explained by the distribution of snail intermediate host and its association to anthropogenic sources. This was also observed in previous studies (Kouadio *et al*., 2023).

In this study, the mixed infection observed between *S. haematobium* and *S. mansoni* were low and in consonance with the studies carried out in Cote d'ivoire (Kouadio *et al*., 2023). Also, age related differences in infection patterns may influence disease epidemiology and control as reinfection has been observed after praziquantel treatment in endemic areas. This could be as a result of overlap of the conditions that favor coexistence of both species of snail vectors for *S. haematobium* and *S. mansoni*. Some of these conditions include the existence of wet soils maintained by high rainfalls, optimal temperatures for parasite survival, and domestic activities that predispose communities to infections at the bank of rivers. This is in conformity with the findings of Meurs *et al*. (2012).

Conclusion

The findings of this research assert that urinary and intestinal schistosomiasis remains prevalent in rural communities in Lokoja, the capital of Kogi State, where there is insufficient access to clean water and where citizens depend on fresh water for their domestic and occupational activities as part of the risk factors. Also, the high prevalence of schistosoma infections in this study highlights the heavy burden on the health and well-being of those who are persistently infected as a result of human attitudes, cultural beliefs and socio-economic status.

Recommendation

There is need for proper health education of the populace and monitoring, which should also be included in school curriculum. Laws to disallow open defecation and urination practices close to freshwater bodies should be implemented.Government and other agencies should ensure access to clean water and basic sanitary measures in rural communities. Mass drug administration should be encouraged and health agencies should ensure the monitoring of MDAs (mass drug administration) impact frequently.

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