Research Paper

Integrated control of river and pond water as an exposure source to urogenital schistosomiasis of rural inhabitants in southern Taraba State, Nigeria

Robert Soumay Houmsou, Emmanuel Binga Wama, Hemen Agere, John Ador Uniga, John Bwamto Bingbeng, Jerry Timothy Jerry, Paul Azuaga, Elizabeth Une Amuta and Santaya Larit Kela

ABSTRACT

The study investigated the infection level and behavioural factors exposing rural inhabitants to urogenital schistosomiasis in Takum Local Government Area, Taraba State, Nigeria. Filtration technique determined *Schistosoma haematobium* eggs from urine samples. Questionnaires collected socio-demographic characteristics and ponds/rivers/streams' behavioural attitudes of participants. An infection of 41.1% was found. Sufa significantly had the highest infection (62.5%) ($\chi^2 = 32.34$, $p = 0.001$) as well as the age groups 1–10 years (47.2%) and 11–20 years (49.6%) ($\chi^2 = 33.83$, $p = 0.001$). Participants with non-formal education and farmers, respectively, had higher infection (45.7%) ($\chi^2 = 12.08$, $p = 0.001$) and (48.5%) ($\chi^2 = 5.42$, $p = 0.020$). Inhabitants who played in ponds/rivers/streams during dry season as well as those with non-formal education and farmers were more predisposed to infection with respective crude odds ratio (cOR) of 0.92 (%95CI: 0.81–1.50; $p = 0.043$), 0.55 (%95CI: 0.38–0.77; $p = 0.001$) and 0.80 (%95CI: 0.33–1.41; $p = 0.002$). Inhabitants were infected according to their wards as well as their age groups, education level, occupation level and behavioural activities. The federal and state governments should embark on public health education and control of the disease.

Key words | inhabitants, risk, riverine, rural, schistosomiasis, urogenital

HIGHLIGHTS

- First epidemiological study in Takum Local Government reporting the vulnerabilty of rural inhabitants to river and pond water sources.
- Water activities like farming of rice, playing and washing in ponds/streams/rivers exposed inhabitants to urogenital schistosomiasis.
- Deterioration of bore-holes and absence of pipe-borne potable water motivated and mandated rural inhabitants to riverine and pond activities.

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INTRODUCTION

Schistosomiasis is a disease caused by a parasitic trematode fluke. The flukes are mainly *Schistosoma haematobium* and *Schistosoma mansoni*. They have a low mortality rate but cause chronic illness that can, respectively, damage vesical and hepatical organ tissues. Urogenital schistosomiasis usually causes haematuria and mostly dysuria. The disease has been reported as the most devastating illness in developing countries. Recently, it was observed that urogenital schistosomiasis affects infected females by causing pain and/or bleeding during sexual intercourse. Moreover, it causes inflammation of the cervix, endometrium layer and/or of the fallopian tubes, leading to infertility (WHO 2015). In endemic areas, female genital schistosomiasis (FGS) can also be a common gynaecological condition in rural and urban areas (WHO 2015). Intestinal schistosomiasis, unlike urogenital, causes abdominal pain by affecting the liver or spleen and even causing bloody diarrhoea in infected individuals (WHO 2020). Urogenital and intestinal schistosomiasis economically destroys agricultural outcomes by causing the aforementioned morbidities and mortality of rural inhabitants (Dawet *et al.* 2012). Schistosomiasis is exposing an estimated population of 779 million people to infection around the world. An estimate of 240 million individuals are already infected with the disease (WHO 2013).

In Africa, the distribution of the disease is focalized and mostly restricted to areas with peculiar ecology, climate change, proximity to water bodies, irrigation, dam constructions and altitude (Houmsou *et al.* 2015; Oluwaremilekun *et al.* 2016). In sub-Saharan Africa, inhabitants recorded the bulk of infection having 97% individuals at risk of the worldwide estimate (WHO 2010). Previous reports estimated 29 million people infected and 101.3 million at risk of infection in Nigeria (WHO 2010). The infection is common in children who had recreational activities such as swimming or playing in infested water (Bishop *et al.* 2016; Houmsou *et al.* 2016; Atalabi *et al.* 2017; Babamale *et al.* 2018).

Cultural, environmental, indigenous, social and mostly behavioural attitudes are dispositional factors that directly influence the prevalence and intensity of schistosomiasis in endemic areas. It is important that those factors are identified so as to help design an effective control programme of the disease in the study area. In several areas of Taraba State, Nigeria, there is a dearth of knowledge on the factors associated with schistosomiasis transmission in rural areas. The local residents and Directorate of Primary Health, Takum Local Government Area (LGA) reported that no research study and even control methods against schistosomiasis have been adopted in the area. Takum LGA is one such area in Taraba State where various dispositional factors contribute to infection with *Schistosoma* sp. Moreover, intermediate snail vectors *Bulinus* sp. and *Melanoides* sp. were observed in vegetation within rivers and ponds or attached to rocks of the rivers or ponds. This study determined the infection level as well as risk factors of urogenital schistosomiasis among the rural inhabitants of an agricultural area of southern Taraba State, Nigeria.

METHODS

Study area

Takum LGA of Taraba State, Nigeria is located between latitude 07° 15″ N and longitude 09° 59″ E and has an area of 2,503 km^2 with a population of 135,349 people (National Population Commission 2006). The area is drained and traversed by several ponds, streams and rivers which serve as recreational and daily chore activities undertaken by the communities' inhabitants.

The LGA borders the Republic of Cameroon to the south, Ussa LGA to the east, Donga LGA to the north and Katsina-Ala LGA, Benue State to the west. The LGA has ten wards, but only seven with applicability and suitable roads were selected for the study. They are Barki-Lissa, Birama, Chanchanji, Kashimbila, Manya, Malumshe and Sufa (Figure 1).

Most of the inhabitants are peasant farmers while non-farmer residents of the area are predominantly civil servants, teachers, nurses, community health workers and

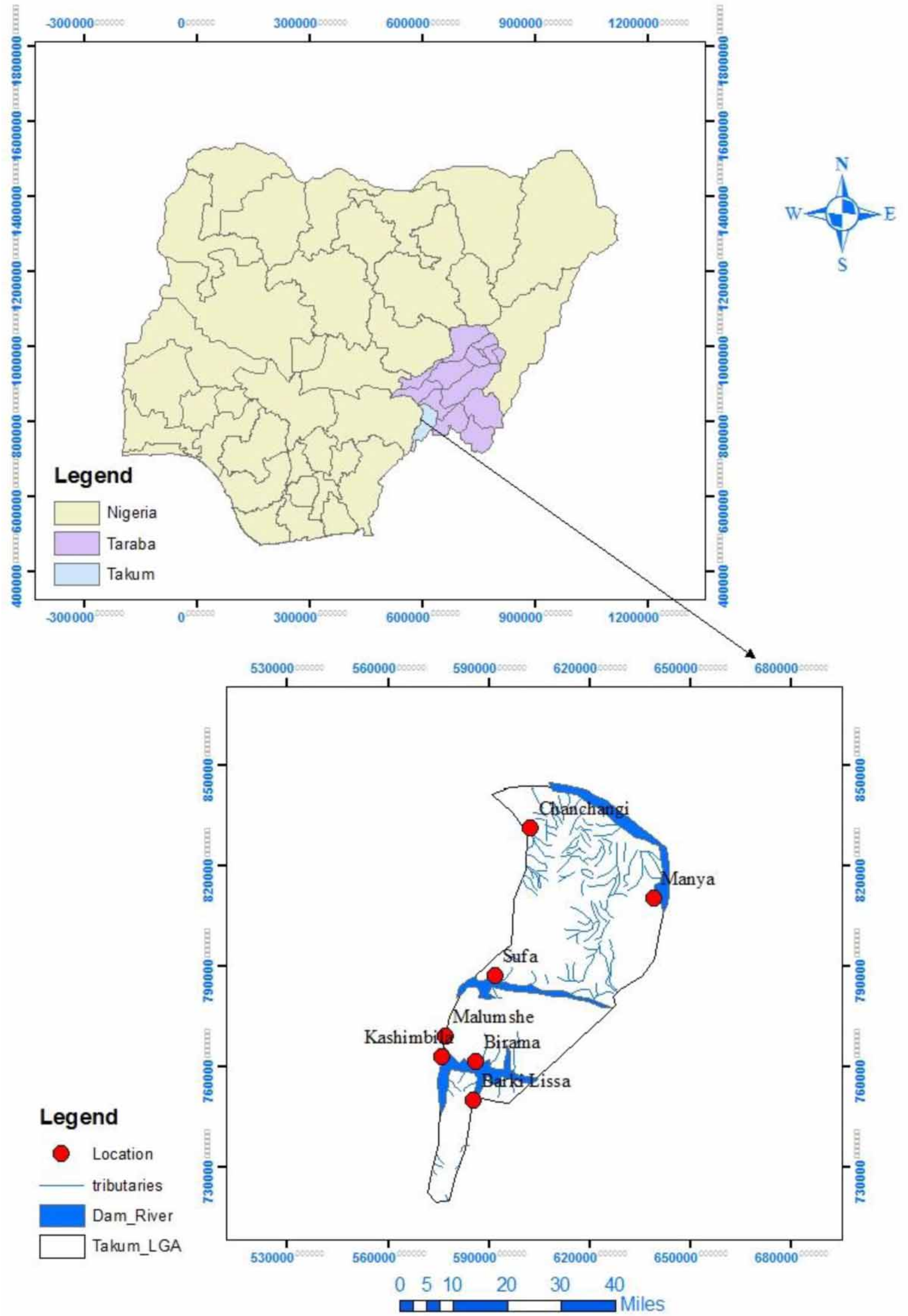

Figure 1 | Map of study area.

business men. The LGA is an area of intense agricultural and fishing activities.

The climate of the area is tropical with vegetation characterized by a typical Guinea savannah interspersed with gallery forest. There are two distinct seasons, the rainy and dry seasons. The former is from mid-March to mid-October while the latter is from mid-October to mid-March. The annual rainfall ranges between 1,200 mm and 2,000 mm annually, while average temperature is between 28 and 32 °C reaching a peak at 37 °C in March and April.

Ethical permission

Prior to the commencement of the study, inhabitants were enrolled into the study following ethical rules. The ethical permission (TLG/PHC/403) was obtained from the Directorate of Health, Takum Local Government Area, Taraba State.

Exclusion and inclusion of participants

Eight hundred and seventy-five inhabitants were enrolled in the study. Participants were excluded due to insufficient urine samples, menstruation and illness of individuals. Participants eligible for the study were healthy, sincere and ready for sampling.

Flow diagram of eligible and non-eligible participants

Figure 2 is the flow diagram of the study showing the informative and well-structured mechanism of inclusion and exclusion of the participants. Initially, there were 875 inhabitants involved in the study. The ineligibility of participants ($n = 97$) was according to their illness and menstruation. They were as follows: Barki-Lissa ($n = 14$), Birama ($n = 14$), Chanchanji ($n = 15$), Malumshe ($n = 14$), Manya ($n = 13$) and Sufa ($n = 14$). The interview included participants that met the criteria for eligibility ($n = 778$). The final recruitment re-interviewed and excluded participants that did not meet the criteria ($n = 103$). The exclusion was based on the refusal to submit urine sample, women with menses, sick individuals and those that had insufficient urine sample. There were 675 participants fully recruited in the study. The participants recruited from each ward were as follows: Barki-Dutse ($n = 97$), Birama ($n = 96$), Chanchanji ($n = 95$), Kashimbila ($n = 97$), Malumshe ($n = 96$), Manya ($n = 98$) and Sufa ($n = 96$).

Study design and sample size determination

The study was cross-sectional in design and conducted from May 2017 to June 2017. A random sampling was used to select seven wards that were traversed and drained by rivers or streams in Takum LGA. The inhabitants enrolled were determined by Cochran sample size formula (Israel 1992):

$$N = \frac{Z^2 \cdot P(1 - P) \cdot D}{E^2}$$

where, $P = 10\%$ assumed prevalence in the area; $E =$ desired precision level ($\alpha = 0.05$ for the assumed prevalence); $D = 1$ reflected the design effect of the simple random sampling that was used for enrollment of subjects. $Z = 1.96$ for two tails.

At calculation, the assumed inhabitants to be sampled by ward were 138. The research team limited the number of inhabitants to be enrolled to 125 by ward. For the seven wards, 875 inhabitants were enrolled.

Questionnaire administration

All ages considered for the study were each issued a questionnaire to gain information on their socio-demographic characteristics and rivers/ponds/streams' behavioural attitudes. The behavioural attitudes were based towards water activities such as fishing, swimming, fishing and swimming, washing and season of playing in water bodies. Verbal interview and questionnaires were undertaken, respectively, to each parent/guardian that enrolled a child or children. In this category, enrolled childen were aged between three and seven years. They were involved in swimming, fishing, playing, wading and washing clothes or utensils in rivers/ponds/streams. Research officials interviewed and filled in the questionnaires for most parents/guardians who were illiterate.

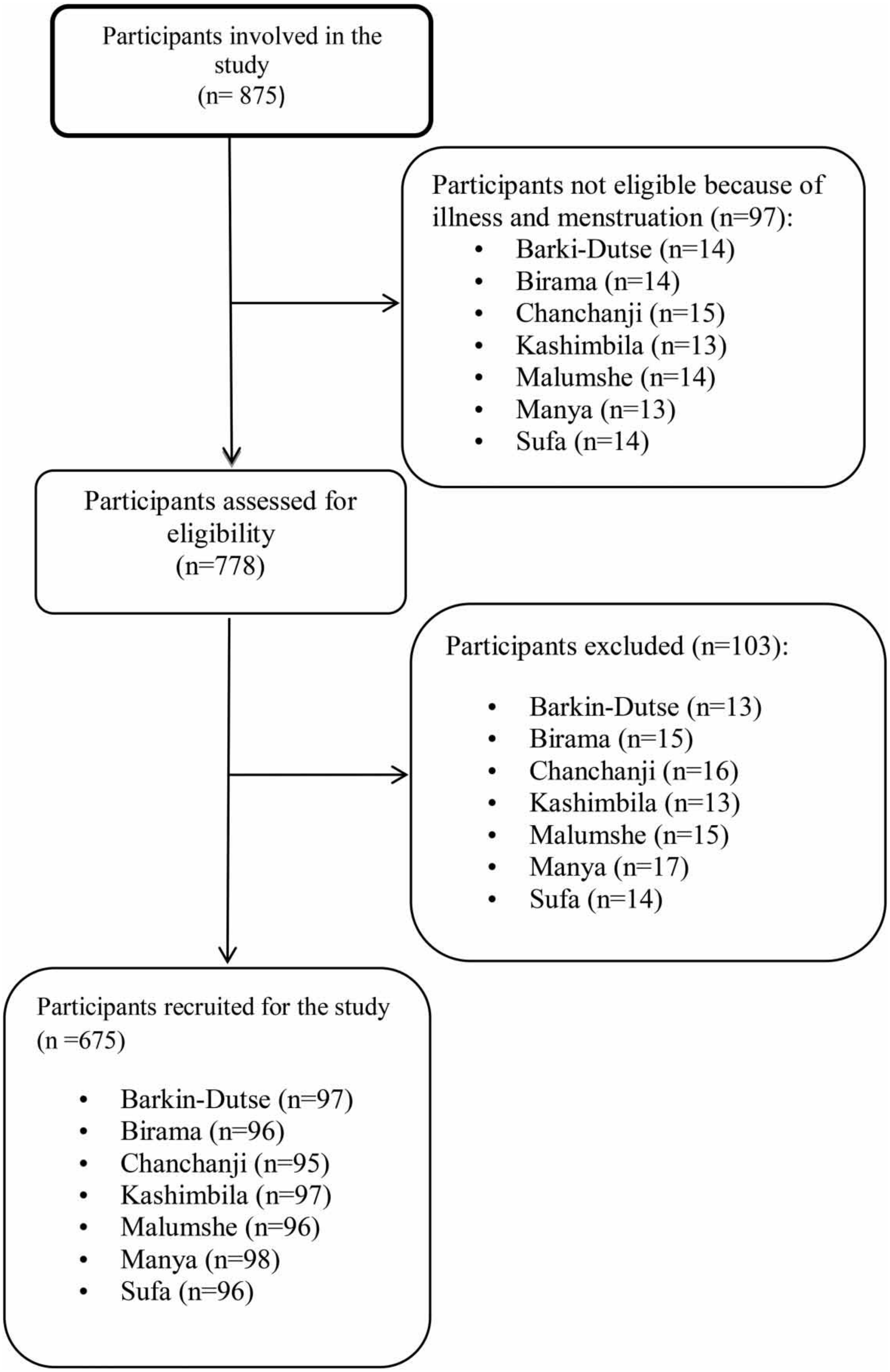

Figure 2 | Flow diagram of eligible and non-eligible participants.

Laboratory examinations

Urinalysis for microhaematuria and proteinuria

Each participant was given a universal labelled bottle for urine collection. Medi-Test Combi 9 (Macherey-Nagel GmbH & Co.KG, Germany) reagent strips were used for the determination of microhaematuria and proteinuria. Microhaematuria and proteinuria levels were measured, respectively, with erythrocytes (μL) and albumin (g/dL). The degrees of microhaematuria were as follows: 0 (negative), *c.*5–10 (+), *c.*50 (++) and *c.*250 (+++), while for proteinuria concentrations were as follows: 0 (negative), *c.*30 (+), *c.*100 (++) and *c.*500 (+++).

Microscopic examination and classification of *S. haematobium* eggs

Each urine sample used the standard filtration technique as the best parasitological method. The filtration technique used a 10 mL syringe, swinnex filter holder of 13 mm diameter and polycarbonate membrane filters (13 μm porosity and 13 mm diameter) (Sterlitech Corporation, Kent, USA). The technique recovered *S. haematobium* eggs in the laboratory. Microscopic examination was done under the 10× and 40× objectives of the binocular microscope for the shape, size and spine characteristics of the *S. haematobium* eggs. Eggs were classified as 1–49 eggs/10 mL of urine and ≥50 eggs/10 mL of urine, respectively, for light and heavy intensities of infection (WHO 2002).

Data analysis

Data were entered and sorted into Microsoft Excell 2014. Data were exported to IBM SPSS Version 23.0 for descriptive and inferential statistics. Chi-square (χ^2) was used to compare infection level between the various socio-demographic characteristics of participants. Binary logistic regression evaluated the relationship of participants with their behavioural factors to pond, stream and river activities. All significance of the tests were at $p \leq 0.05$.

RESULTS

Socio-demographic characteristics of study participants

The inhabitants recruited were male (48.8%) and female (51.1%). The mean age ± standard error (SE) of participants involved in the study was 21.19 ± 0.65 years. The minimum age was 3 years and maximum 75 years. The ages were grouped as 1–10 years (37.9%), 11–20 years (20.2%), 21–30 years (19.7%), 31–40 years (9.6%) and ≥41 years (12.4%). The formally educated inhabitants were (32.3%) and non-formally educated (67.7%). For occupational level, non-farmers were (26.2%) and farmers (73.7%) (Table 1).

Urogenital schistosomiasis in relation to socio-demographic factors of participants in Takum LGA, Taraba State, Nigeria

The overall infection level of urogenital schistosomiasis in Takum LGA, Taraba State, Nigeria was 41.1%. The

Table 1 | Socio-demographic characteristics of study participants ($N = 675$)

Characteristics	Value (%) (n)
Sex	
Male	330 (48.8)
Female	345 (51.1)
Age (years)	
Mean ± SE	21.19 ± 0.65
Minimum	3
Maximum	75
Age groups	
1–10	256 (37.9)
11–20	137 (20.2)
21–30	133 (19.7)
31–40	65 (9.6)
≥ 41	84 (12.4)
Education	
Formal	218 (32.2)
Non-formal	457 (67.7)
Occupation	
Farmer	177 (26.2)
Non-farmer	498 (73.7)

infection related to the inhabiants' areas showed Sufa with the highest infection level (62.5%) while Chanchanji had the lowest (24.2%). A significant difference in infection was observed between locations ($\chi^2 = 32.34$, $p = 0.001$). Males had lower infection (38.1%) than females (44.0%) with no significant difference ($\chi^2 = 2.40$, $p = 0.121$). The age-related infection respectively showed that the age groups 1–10 and 11–20 years significantly had the highest infection levels with 47.2% and 49.6% than other age groups ($\chi^2 = 33.83$, $p = 0.001$). The educational background of inhabitants showed that those with non-formal education significantly had higher infection (45.7%) than those that had a formal education (31.6%) ($\chi^2 = 12.08$, $p = 0.001$). In relation to occupation, farmers significantly had more infection (48.5%) than non-farmers (38.5%) ($\chi^2 = 5.42$, $p = 0.002$) (Table 2).

Table 2 | Urogenital schistosomiasis in relation to socio-demographic factors of communities in Takum LGA, Taraba State, Nigeria

	No. examined	No. positive (%)	χ^2	*p*-value
Overall	675	278 (41.1)		
Location			32.34	0.001
Barki-Lissa	97	44 (45.3)		
Birama	96	36 (37.5)		
Chanchanji	95	23 (24.2)		
Kashimbila	97	38 (39.1)		
Malumshe	96	42 (43.7)		
Manya	98	35 (35.7)		
Sufa	96	60 (62.5)		
Sex			2.40	0.121
Male	330	126 (38.1)		
Female	345	152 (44.0)		
Age groups (years)			20.13	0.001
1–10	256	121 (47.2)		
11–20	137	68 (49.6)		
21–30	133	42 (31.5)		
31–40	65	17 (26.1)		
≥ 41	84	30 (35.7)		
Education			12.08	0.001
Formal	218	69 (31.6)		
Non-formal	457	209 (45.7)		
Occupation			5.42	0.002
Farmer	177	86 (48.5)		
Non-farmer	498	192 (38.5)		

Educational, behavioural and occupational attitudes of rural inhabitants as risk factors of urogenital schistosomiasis in Takum LGA, Taraba State, Nigeria

Table 3 summarizes the educational, behavioural and occupational attitudes that exposed rural inhabitants to urogenital schistosomiasis in Takum LGA, Taraba State, Nigeria. The rural inhabitants who played in rivers/ponds/streams during the dry season had the highest infection (84.2%). They were exposed to infection with a crude odds ratio (cOR) of 0.92 (%95CI: 0.81–1.50, $p = 0.043$) which was significantly different in rural inhabitants than other attitudes' activities. The non-formal education and farming significantly exposed rural inhabitants to infection with respective cOR of 0.55 (%95CI: 0.38–0.77, $p = 0.001$) and cOR of 0.80 (%95CI: 0.33–1.41, $p = 0.002$).

DISCUSSION

Schistosomiasis still remains a serious public health problem in many developing countries, particularly among inhabitants living in rural areas of sub-Saharan Africa. Nigeria has been considered as the most endemic country with approximately 29 million individuals with infection and 101.7 million of individuals at risk (WHO 2013). Control of schistosomiasis has not been seriously prioritized towards the rural inhabitants. This has entirely dismantled the trust of the rural inhabitants towards the community health workers and the government. This study revealed 41.2% mesoendemic infection according to WHO classification (WHO 2013). The infection found in the area was by the exposure to various infested water sources from rivers/ponds/streams through daily chores and recreational activities. Moreover, the failure of government in achieving the Sustainable Development Goals towards implementation of clean water sources for use in rural areas has seriously affected the health of rural inhabitants. From our investigation with the community leaders, no mass administration of the drug praziquantel was carried out in the area thereby leaving so many rural inhabitants infected with the disease.

Table 3 | Educational, behavioural and occupational attitudes of rural inhabitants as risk factors of urogenital schistosomiasis in Takum LGA, Taraba State, Nigeria

Risk factors	No. examined	No. positive (%)	cOR	%95CI	*p*-value
Swimming					0.189
Yes	320	235 (73.4)	0.91	0.55–1.68	
No	77	43 (55.8)			
Fishing					0.168
Yes	180	141 (78.3)	2.64	0.87–7.46	
No	217	137 63.1)			
Swimming and fishing					0.415
Yes	183	137 (74.8)	2.54	0.87–7.46	
No	214	141 (65.8)			
Washing in water bodies					0.651
Yes	257	215 (83.6)	0.92	0.56–1.50	
No	140	63 (45.0)			
Season of playing in water					0.043
Dry season	266	224 (84.2)	0.92	0.56–1.50	
Rainy season	167	18(10.7)			
Education					0.001
Formal	218	69 (31.6)	0.55	0.38–0.77	
Non-formal	457	209 (45.7)			
Occupation					0.002
Farmer	177	86 (48.5)	0.80	0.33–1.41	
Non-farmer	498	192 (38.5)			

cOR, crude odds ratio.

The study has supported similar and previous reports that have consistently shown endemicity of *S. haematobium* infection in Nigeria, particularly in the rural areas (Babamale *et al.* 2018; Muhammad *et al.* 2019; Otuneme *et al.* 2019). The infection is lower than previous studies: 62.0% of internally displaced children in Maiduguri, Borno State (Yauba *et al.* 2018), 64.5% in Owena, Kajola and Baiken communities bordering Owena reservoir/dam, Ondo East Local Area, Ondo State, southwest Nigeria (Peletu *et al.* 2018) and 58.5% in Taraba State (Houmsou *et al.* 2016). However, this study reported higher infection than 2.9% and 14.5% found, respectively, in districts of Anambra State, southeast Nigeria and Adim rural community of Cross-River State, south-south Nigeria (Ekanem *et al.* 2017; Ndukwe *et al.* 2019). Low infection of 5.8% of urogenital schistosomiasis has been reported among primary schoolchildren of rural farmers in Agyaragu Community, Lafia LGA, Nasarawa State, Nigeria (Ayuba *et al.* 2020). In a sub-Saharan country, a low infection rate of 15.0% was found among inhabitants of a rural area, Kwale County, Kenya (Kaiglová *et al.* 2020). Schistosomiasis has been focally distributed in ponds, rivers and streams in the rural areas. Infection levels have varied from one community to another in Nigeria and elsewhere in sub-Saharan countries (Peletu *et al.* 2018; Teckla *et al.* 2018; Kaiglová *et al.* 2020). Globally, high infection levels of urogenital and intestinal schistosomiasis have been reported in other countries like Namibia, Tanzania, Ghana, Ethiopia, Zimbabwe and Côte d'Ivoire (Nicaise *et al.* 2013; Abebe *et al.* 2014; Adenowo *et al.* 2015; Wami *et al.* 2015; Mupakeleni *et al.* 2017).

The present result was insignificant between females and males. The insignificance observed between females and males would have been attributed to the similar cultural attitude of rural individuals towards riverine, pond and stream water activities like fishing, playing, wading and washing during the dry season in the area. Ekpo *et al.* (2012) reported similar attitudes with females who had higher infection than males in Ogun State, Nigeria. Bakhit *et al.* (2011) reported the same in Khartoum, north Sudan where males had lower infection than females. The provision of clean and potable water through supply of boreholes and purification of water into wells was not promoted in the areas. The attitude of rural inhabitants relying on untreated water is known in Nigeria (Ishaku *et al.* 2011; Sridhar *et al.* 2020) and other areas of sub-Saharan Africa countries (Geremew & Damtew 2020). Improvement in such conditions will grant good health and economic success to rural inhabitants.

The infection level of *S. haematobium* in this study was not affected by age although the age groups 1–10 and 11–20 years had higher infection than other age groups. The age groups were equally exposed to schistosomes' cercariae. It was observed in the area that inhabitants, irrespective of their age, were involved in water contact activities through bathing, fishing and recreation. From our investigations, ponds, rivers and streams used by inhabitants in Sufa, Malumshe, Barki-Lissa, Birama and Kashimbila were populated with snail intermediate hosts. In most of the communities surveyed, no potable water either pipe-borne, boreholes and wells were available. Even in communities where boreholes and wells were present, inhabitants usually refused to use them because of the stress in pumping the boreholes and difficulty in fetching water regularly from wells. The act of having clean water with boreholes was neglected. This forced them to always have contact with cercariae-infested ponds, rivers and streams exposing their bodies to infection. The highest infection of 47.3% and 49.6% was respectively for 1–10 years and 11–20 years. They were unware and more insensitive of their social behaviour with infested sources of water that exposed them to infection. People aged 31–40 years had 26.2% infection which was the lowest. This low prevalence from adult inhabitants might be due to their naturally acquired immunity against *S. haematobium* and less water contact activities (Agbolade *et al.* 1996). Moreover, it was also observed that inhabitants of that age group had alternative means of recreation. For those behavioural attitudes observed among the lower age groups the control of urogenital schistosomiasis needs to be implemented as in Tanzania (Knopp *et al.* 2016).

Water contact activities of the studied population showed that recreational activities with regard to ponds, rivers and streams during the dry season increased the transmission of schistosomiasis from the snail intermediate hosts to humans. This study showed a strong association between the season of playing in rivers/ponds and infection level. A similar observation was also reported that swimming and playing in water bodies during the dry season increased the transmission of schistosomiasis in Bafia, southwest region, Cameroon and Kaedi town, southern Mauritania (Gbalégba *et al.* 2017; Ndassi *et al.* 2019). This infection could be controlled in the local government areas if water recreation areas were to be created as in a Ghanaian community (Kosinski *et al.* 2012). The communities should also be educated on the daily use of clean water found in boreholes and wells. This good attitude will then control schistosomiasis in the affected areas. Such attitude has been observed in endemic communities of Kenya (El Kholy *et al.* 1989).

Non-formal education level caused rural inhabitants not to adopt preventive measures against the schistosome cercariae-infested water of rivers/ponds/streams thereby exposing them to infection. Equally, occupation influenced the infection level. Farmers who indulged in farming activities had a higher level of infection than non-farmers. This might be partly due to their constant exposure to infested water bodies with schistosome cercariae where they are engaged in self-sustained labour such as local rice '*fadama*' farming and bathing. The infection observed among non-farmers could be their exposure to cercariae-infested rivers and ponds through bathing, wading and swimming.

The Sustainable Development Goal was not achieved in the rural areas investigated due to the daily dependence of the inhabitants on rivers and ponds. This is the major issue of the rural inhabitants in those areas for them to be free from urogenital schistosomiasis and other water-based infectious diseases.

The limitations of the research study were the lack of required laboratory techniques and properly trained female gynaegologist midwives (nurses), respectively, for proper examination and treatment of the infected inhabitants in primary health care centres. There was also a lack of laboratory equipment at the various primary health care centres although the research team had their mobile laboratory equipment. The lack of knowledge by the inhabitants, laboratory technicians and community health workers on schistosomiasis and its transmission were observed to be major problems in the areas. The lack of a road to some of the endemic rural communities did not permit us to examine the inhabitants that are located in farther distanced rural communities. The agrarian outlook of the inhabitants delayed their attendance to laboratory examinations at the required hours (10:00am–2:00pm).

CONCLUSION

The study found a mesoendemic schistosomiasis area in a southern part of Taraba State, Nigeria. Barki-Lissa had the highest infection level while Kashimbila had the lowest. Age-related infection showed that the age groups 1–10 years and 11–20 years had higher infection than other age groups. The participants with non-formal education significantly had a higher infection than those with formal education. Farmers significantly had a higher infection than the non-farmers. The participants that played in water bodies during the dry season, those with non-formal education and farmers were significantly more exposed to infection.

Integrated control of urogenital schistosomiasis could be achieved in the areas if government and the rural health workers were sincere. This can be fulfilled through preventive health education of the rural communities. Their indigenous beliefs were against the collection of urine for examination. An annual distribution campaign of praziquantel in the areas would have been better than the one given to affected individuals in the field. This might have been effective and efficient annually for the rural inhabitants to control the disease in these communities. They can also be educated in local and common language '*jukun*' to avoid behavioural water activities daily in ponds, rivers and streams. This will help the communities avoid exposure to cercariae from snail intermediate hosts.

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There is no conflict of interest.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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