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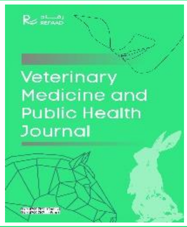

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Abstract

Urinary schistosomiasis is a tropical parasitic disease caused by *Schistosoma haematobium* and is usually associated with lesions in the genito-urinary tracts of affected people. A cross-sectional study was designed to examine factors influencing the occurrence of the disease among inhabitants of the IDP camps located in Maiduguri between October 2016 and June 2019. Information on demography, major sources of water supply and water-contact behaviours were obtained using pre-validated structured questionnaire. Urine samples were collected and examined for *Schistosoma haematobium* eggs using standard methods. A sample yielding at least one egg was considered positive while a sample that did not yield any was considered to be negative. The characteristics and disease risk factors were compared between respondents that tested positive and those that were negative for the infection using univariable statistical analysis and factors found to be significant were further analyzed using multivariable logistic regression. The results showed the overall prevalence of infection among the IDPs to be 21.9% (95% Confidence Interval, 95% CI= 19.54-24.42%). The multivariable logistic regression model showed that the statistically significant ($p<0.05$) predictors of infection including sex, occupation ($\chi^2 = 9.873$, df=4, p=0.04), participation in water sporting activity and having washed/bathed in open water body before displacement, presence of signs of the disease in a tent/room member, knowledge of the disease and major source of water supply ($\chi^2 = 72.467$, df=2, p<0.001) before the displacement. The relatively high prevalence of the disease in the study area may have negative effects on the reproduction and productivity of the IDPs. Based on the identified risk factors, behavioural changes, improved sanitation and safe water supply were recommended as control measures against urinary schistosomiasis in the study area.

Keywords: *Urinary Schistosomiasis; Prevalence; Risk Factors; IDP-Camps; Maiduguri.*

1. Introduction

Schistosomiasis is a water-borne parasitic disease of the tropical and subtropical regions infecting more than 200 million people globally (Richardson, et al. 2016). It is ranked the second most important parasitic disease in the world after malaria, in terms of prevalence and persistence with grave public health and socio-economic importance in endemic communities (Tucker et al., 2013) (Kazibwe, et al., 2006).

The urinary form of this disease caused by blood fluke, *Schistosoma haematobium* may result in granulomatous inflammation, ulceration and pseudopolyposis of the vesical and ureteral walls in the affected people (Gryseels et al., 2006). The disease has significant socio-economic impacts on impoverished communities and may compete with other diseases for the allocation of scarce health care resources in the most affected low-income countries. It has profound negative effects on child development, reproduction and agricultural productivity (Adenowo et al., 2015).

In Nigeria, about 25.83 million people were estimated to be infected with Schistosomes with an estimated total of 101.28 million people being at risk of infection (Chitsulo et al., 2006). In Borno State, the situation is not different as urinary schistosomiasis was once ranked as the second most common communicable disease in the state (Chikwem & Alaku, 1987) with the relatively recent reported prevalence of 48.7% among out-of-school children in Dikwa Local Government Area (LGA) (Baba et al., 2015) and 24.3% among schoolchildren in Konduga LGA (Biu et al., 2009).

The Boko Haram insurgency has resulted in the displacement of a large proportion of the population which might have altered the dynamics of endemic diseases in the population. Therefore, there is a need for investigation of diseases in such a population with the view to proffering disease control measures. This is because the internally displaced persons (IDPs) have minimal access to health care, necessities of life and good sanitary conditions (Omole et al., 2015). These factors generally predispose to diseases and the fact that the IDPs mostly access water from open water sources may further favour transmission of schistosomiasis. The insurgency may have influenced the occurrence of schistosomiasis as most of the inhabitants who rarely go to stream do so as a result of lack of potable water due to the security challenges in the affected area (Baba et al., 2015). Previous studies from the State showed that children are the most affected age group (Chikwem, 1987: Baba et al., 2015: Biu et al., 2009: Isa et al., 2017: Chugh et al., 1986). Factors reported to be responsible for the persistence of the disease, in general, included the climatic changes and global warming, proximity to water bodies, irrigation and dam construction as well as socio-economic factors such as occupational activities and poverty (Adenowo et al., 2015). However, the epidemiology of the disease in the displaced population is not fully understood as information on the subject in the available literature is scarce. Therefore, this study was designed to investigate the distribution and factors associated with urinary schistosomiasis among the IDPs in Maiduguri. Elucidating the relationship between risk factors associated with urinary schistosomiasis among IDPs is of immense significance as it may serve as a veritable tool in planning effective control measures with the view to reducing those risks.

2. Methods

Study Design:

A cross-sectional study was designed to investigate the distribution and factors influencing the occurrence of urinary schistosomiasis among the inhabitants of IDP camps in Maiduguri. The study was carried out between October 2016 and June 2019 following anecdotal reports of increased disease burden among inhabitants of the various IDP camps in Maiduguri metropolis.

Study Area:

The study was carried out in three IDP camps namely: Dalori camp, National Youth Service Corps (NYSC) camp and Government College camp. All three camps were located within Maiduguri Metropolis. Maiduguri is the capital of Borno State, North-eastern Nigeria. The city is located on latitude 11.833333^{0}N and longitude 13.150000^{0}E of the equator. It is the largest city in the northeastern part of Nigeria. The city is situated about 325 meters above sea level. The two main vegetation zones in the state are the Sudan savannah in the south and Sahel savannah in the north. Figure 1 shows a map of the north-eastern part of Nigeria showing major towns that were displaced by the Boko Haram insurgency. The climate is semi-arid and is characterized by a hot season which spans from March to June with daily temperature varying between 30 to 41°C and the cold season which spans from November to February with a daily temperature of between 26 and 13°C (Eresanya, 2018). The population of the city was estimated to be 731,700 in 2015 with a population density of 5,543.2 inhabitants per km^2. Rivers (Yedzaram, Ngadda, etc), dams (Alau, Biu dam) streams and ponds found scattered across the state constituting the hydrologic network.

Study Population:

The study population comprised of individuals displaced from different parts of the state into Maiduguri Metropolis. The insurgency, since 2009 had resulted in the displacement of about 1.2 million people to the city (Fig. 1) out of which about 100,000 live in various IDP camps (Burki, 2016).

Fig (1): A map of the northeastern part of Nigeria showing major towns that were displaced by the Boko Haram insurgency.

An estimated population of 20,000 was identified in Dalori camp who are mainly from Bama Local Government Area (LGA). The ID from Bakasi camp had an estimated population of about 6,000 and were mainly from Gwoza LGA. The estimated number of IDPs from the NYSC camp was 10,000 and they were from Gwoza, Konduga and Damboa LGAs. The insurgency affected mostly the central, northern and south-eastern parts of the state (Fig. 1). Out of 1,918,508 IDPs, 94% were displaced by the insurgency in north-eastern Nigeria (UNHCR & World Bank, 2016). The total number of IDPs identified in Borno State was estimated to be about 672,714 IDPs.

A total of 1,247 individuals had voluntarily agreed to participate in the study and were issued urine sample containers. Out of this total 1,082 (86.8%) of them, aged between one and 82 years and of both sexes were included in the study.

Sample Size Determination:

The minimum sample size for the study was calculated based on the *S. haematobium* infection prevalence of 13.9% reported by (Isa et al., 2015) for communities living along Lake Alau, Konduga Local Government, Borno State. The sample size was determined using the formula for calculation of the sample size of cross-sectional study recommended by (Charan & Biswas, 2013) as follows:

Sample size $$n = \frac{z^2 p(1-p)}{d^2}$$

Where:
n = sample size
z = statistic for the level of confidence (95% CI)
P = expected prevalence from previous study of 13.9 reported by (Isa et al., 2015)
d = allowable error (5%)
After substituting the above parameters in the formula, we have:

$$n = \frac{(1.96)^2\ X\ 0.139X\ (1-0.139)}{(0.05)^2} = 184$$

Therefore, a minimum of 184 respondents was required from each of the 3 camps in the study making a total minimum of 552 respondents required for the study. However, to increase the precision of the estimates of the prevalence rates the sample size was increased to 1,082 respondents.

Selection of Respondents:

The selection of the respondents for the study was based on the procedure described by (Dawaki et al., 2016). Accordingly, before the commencement of the study, the objectives and plan were explained to the officials of the selected camps and leaders of the inhabitants to obtain their permission and cooperation. Then, the leaders requested all the inhabitants to gather at the camp clinic where they received briefings on the objectives of the study and request their participation. The inhabitants who voluntarily agreed to participate were recruited for the study. Written informed consent was obtained from each of the respondents. Copies of the consent forms were documented for future reference and review. Each participant received a labelled container and was instructed to bring a urine sample within two hours. The inclusion criteria were that only displaced individuals living in the IDP camps during the time of data collection who agreed and have signed consent forms, completed questionnaires and submitted urine samples for examination were included in the study.

Administration of Questionnaire:

A pre-validated questionnaire was used to collect socio-demographic and other relevant data such as age, sex, number of individuals per room, educational background, occupation, water contact behaviours such as distance from open water sources, water supply sources, and knowledge, attitudes and practices about schistosomiasis. All of these items were considered to be the exposure or predictor variables in this study. To collect data on these predictor variables, trained research assistants were involved in the administration of the questionnaires under the supervision of the researchers.

Samples Collection and Laboratory Analysis:

About 20mls of a single urine sample was collected in a sterile sample bottle from each of the 1,082 respondents from the three selected camps after the questionnaire administration. Each sample was labelled using the respondent's identification number. The samples were preserved on an ice pack and transported to the University of Maiduguri Veterinary Parasitology Laboratory and processed according to the method described by (Hodges et al., 2011). For the examination, 10ml of the urine samples was measured and centrifuge at 15,000 rpm for 5 minutes. After spinning, the supernatant was decanted and the sediment was mixed using a pipette. Part of the sediment was transferred onto a clean glass slide and covered with a coverslip and examined for *Schistosoma* egg. Sample from which at least one egg was seen was classified as positive while one from which no egg was seen as a negative sample. The result of the urine microscopy which can either positive when egg is found or negative when no egg is found was considered to be the outcome variable in this study. All respondents testing positive were referred to the camp clinic for treatment using the WHO-recommended drug.

Data Management and Statistical Analysis:

The data obtained from the questionnaires were entered into Microsoft® Excel for Mac 2011 for collation and clean up. The statistical analyses were performed using IBM SPSS Statistics for Macintosh (Version 23.0; IBM Corp., Armonk, NY, USA). Descriptive analyses were performed for the respondents concerning risk factors. The dependent/outcome variable used in the analysis was the status of the respondents for the result of the urine microscopy. A chi-squared test was used to compare the proportions of categorical variables while an independent t-test was used to analyse continuous variables in univariate analyses. The proportions and their respective confidence limits were calculated using the Wilson Method described by (Brown et al.,2001). To reduce potential sources of bias in the study, a multivariate logistic regression model was constructed using the backward elimination method in which variables with a univariate level of significance $p<0.25$ were selected for inclusion in the base model and variables were excluded if the p-value was >0.05 and did not meaningfully alter the point estimates of the remaining variables. The Chi-squared test for independence was used to assess collinearity between the predictor variables. The overall goodness-of-fit of the model to the data was examined using the Hosmer-Lemeshow test. The p-values <0.05 were considered significant.

3. Results

General Characteristics of the Respondents:

From the total 1,247 individuals that initially agreed to participate in the study, only 1,082 (86.8%) fulfilled the inclusion criteria. The remaining 165 individuals were excluded from the study because some (79) couldn't produce urine samples within the time frame allotted in the study while others (86) opted out of the study due to personal reasons.

Out of the 1,082 respondents that agreed to participate and supplied urine samples for the study, 418 (38.6%) were females while 664 (61.4%) were males. Based on Local Government Area (LGA) of residence before displacement, 488 (45.1%), 75 (6.9%), 355 (32.8%) and 164 (15.2%) were from Bama, Damboa, Gwoza and Konduga LGAs respectively. The average age of the respondents was 38.7 years with a standard deviation of 14.5 and minimum and maximum age as 1 and 81 years respectively. The overall prevalence of schistosomiasis in the study population was 21.9% (95% Confidence Interval, CI 19.54-24.42%).

Prevalence and Univariate Risk Factors of Schistosomiasis Among Inhabitants of IDP Camps in Maiduguri:

Table (1) shows the prevalence and results of univariate Chi-squared tests of the risk factors of schistosomiasis among IDP camp inhabitants reporting odds ratios and their respective 95% confidence intervals (CI).

Table (1): Univariate risk factors of *Schistosoma haematobium* infection among in IDP camp inhabitants in Maiduguri, Borno State, Nigeria

Variable	Category	Number +ve (Prev%)	OR	95% CI	p-value
Sex	Male	128(11.8)	1.57	1.18-2.10	0.002*
	Female	109 (10.1)	Ref	-	-
LGA Camp Located	MMC	138 (12.8)	0.84	0.64-1.15	0.291
	Jere	99 (9.1)	Ref.	-	-
Distance from an open water source	≥1km	112 (10.4)	0.74	0.55-0.98	0.037*
	≤1km	125 (11.6)	Ref	-	-
Participated in water sports	Yes	129 (11.9)	1.56	1.17-2.08	0.003*
	No	108 (10.0)	Ref	-	-
Drink from the same source with animals	No	139 (12.8)	0.76	0.57-1.02	0.063
	Yes	98 (9.1)	Ref	-	-
Knowledge of Schistosomiasis	Yes	108 (10.0)	0.69	0.52-0.92	0.012*
Aware of water-borne disease	Yes	96 (8.9)	0.83	0.62-1.11	0.209
	No	141 (13.0)	Ref	-	-
	No	129 (11.9)	Ref	-	-
Bath/wash in an open water source	Yes	139 (12.8)	1.53	1.14-2.04	0.004*
	No	98 (9.1)	Ref	-	-
Observed signs in a household member	No	137 (12.7)	0.80	0.60-1.07	0.134
	Yes	100 (9.2)	Ref	-	-
Signs in a tent member	Yes	134 (12.4)	1.42	1.06-1.90	0.018*
	No	103 (9.5)	Ref	-	-

*=significantly different, CI=confidence interval, OR=Odds ratio

The results showed significant statistical association between infection with *Schistosoma haematobium* and factors that included sex (χ^2=9.52, df=1, p=0.002), distance from a water source (χ^2 =4.36, df=1, p=<0.037) and contact with water such as bathing/washing in open water source (χ^2 =8.138, df=1, p=<0.004), participation in water sporting activity (χ^2=9.018, df=1, p=0.003), knowledge of schistosomiasis (χ^2=6.318, df=1, p=0.012) and presence of clinical signs in tent-members (χ^2=5.642, df=1, p=0.018). Table (2) shows the descriptive statistics and comparison of mean percentages of respondents with schistosomiasis-positive and negative test results.

Table (2): Descriptive statistics and percentages of schistosomiasis positive and negative respondents

Variable	Descriptive			positive (n=237)		Negative (n=845)		p-value
	Range	Mean	SD	Mean	SEM	Mean	SEM	
No. of children/room	300	16.38	29.79	12.73	1.57	17.40	1.07	0.033*
No. of urinals/tent	22	5.58	4.33	5.23	0.25	5.68	0.15	0.160
No of families/tent	4	2.96	1.06	3.04	0.07	2.94	0.04	0.093

*=significantly different, SD=standard deviation, SEM=standard error of the mean

In terms of children per room/tent, the table showed a significant statistical difference (t=-2.14, df=1080, p=0.033) between respondents with schistosomiasis-positive results compared to those with negative.

Table 3 shows results of a univariate column by row comparison of the risk factors of schistosomiasis among IDP camp inhabitants using a Chi-squared test.

Table (3): Prevalence and univariate column by row Chi-squared tests of risk factors of *Schistosoma haematobium* infection among IDP camp inhabitants in Maiduguri, Borno State, Nigeria

Variable	Categories	Total examined	Number Positive	Prev. (%)	95% CI of Prevalence	p-value
Age Categories	<18years	46	31	67.39	52.87-79.13	0.000*
	≥18-30yrs	352	60	17.05	13.48-21.32	
	≥31-40yrs	284	59	20.77	16.46-25.87	
	≥41-≥81yrs	400	87	21.75	17.99-26.05	
Name of Camp	Dalori	420	99	23.57	19.76-27.86	0.200
	G. C.	344	64	18.60	14.85-23.06	
	NYSC	318	74	23.27	18.96-28.22	
Educational Level	None	108	64	59.26	49.83-68.05	0.000*
	Adult Educ	41	17	41.46	27.76-56.63	
	Qur'anic	679	118	17.38	14.71-20.41	
	Primary	144	23	15.97	10.89-22.83	
	Secondary	94	14	14.89	9.08-23.46	
	Tertiary	12	1	6.25	1.11-28.33	
Occupation	Farmer	363	76	20.94	17.07-25.42	0.000*
	Fisherman	23	17	73.91	53.53-87.45	
	Livestock Handler	75	20	26.67	17.98-37.63	
	Trader	391	70	17.90	14.42-22.01	
	Others	230	54	23.48	18.46-29.36	
LGA of Residence	Bama	488	84	17.21	14.12-20.82	0.004*
	Damboa	75	16	21.33	13.58-31.88	
	Gwoza	355	90	25.35	21.11-30.12	
	Konduga	164	47	28.66	22.29-36.01	
Water supply source	Open water-body	148	104	70.23	62.47-77.05	0.000*
	Treated Tap/pipe	40	9	22.50	12.32-37.50	
	Well/borehole	894	124	13.87	11.76-16.29	
Mode of arrival to camp	Trekking & Vehicle	315	69	21.90	17.69-26.80	0.689
	Rescue	280	67	23.93	19.31-29.26	
	Trekking	339	73	21.53	17.49-26.22	
	Vehicle	148	28	18.92	13.43-25.98	
Signs often seen	Abdominal pain	138	31	22.46	16.30-30.12	0.557
	Fever	637	144	22.61	19.53-26.01	
	Haematuria	90	22	24.44	16.73-34.25	
	Painful urination	217	40	18.43	13.84-24.13	
Treatment of schistosomiasis	Orthodox	874	189	21.62	19.02-24.48	0.318
	Traditional	147	30	20.41	14.69-27.64	
	Combined O & T	61	18	29.51	19.56-41.89	
Prevention	Boiling	285	56	19.65	15.45-24.65	0.164
	Filtration	279	56	20.07	15.79-25.16	
	Boiling & filtration	224	61	27.23	21.82-33.41	
	None	294	64	21.77	17.43-26.83	

*=significantly different, **CI**=confidence interval, **OR**=Odds ratio, **Prev**=Prevalence, **GC=**Government College, **O**= Orthodox, **T**= Traditional

The table showed a significant statistical association between occurrence of urinary schistosomiasis and age of the respondents (χ^2=60.715, df=3, p<0.000), their occupation (χ^2 =41.56, df=4, p<0.000), their Local Government of residence prior to displacement (χ^2 =13.13, df=3, p=0.004) and their level of educational attainment (χ^2 =112.77, df=5, p<0.001). The univariate analysis also showed a significant statistical association between infection and the respondent's major sources of water supply before displacement (χ^2 =236.13, df=2, p<0.001).

Multivariate Logistic Regression:

The result of the multivariate logistic regression for assessment of the investigated potential risk factors for urinary schistosomiasis among the IDPs is presented in Table 4.

Table (4): Multivariate logistic regression of risk factors associated with *Schistosoma haematobium* among inhabitants of IDP camps in Maiduguri, Nigeria

Variable	Category	OR	95% CI of OR	p-value
Sex	Female	0.573	0.400-0.821	0.002*
	Male	Ref	-	-
A distance of Residence from a water source	<1km	0.749	0.517-1.084	0.125
	>1km	Ref	-	-
LGA of Residence before displacement	Bama	0.608	0.364-1.015	0.057
	Damboa	0.503	0.220-1.151	0.104
	Gwoza	1.458	0.834-2.549	0.185
	Konduga	Ref	-	-
Educational Background	Adult Education	5.703	0.584-55.679	0.134
	Quranic	2.200	0.264-18.310	0.466
	Primary	1.976	0.228-17.121	0.537
	Secondary	0.931	0.104-18.073	0.592
	None	1.861	0.192-1.134	0.079
	Tertiary	Ref	-	-
Participated in water sporting activity	No	0.582	0.411-0.825	0.002*
	Yes	Ref	-	-
Occupation of Respondent	Farmer	1.015	0.637-1.618	0.950
	Fisherman	1.767	0.447-6.977	0.417
	Livestock Handler	1.898	0.956-3.766	0.067
	Others	1.825	1.140-2.921	0.012*
	Trader	Ref	-	-
No. of children per room/tent	Positive results	0.995	0.987-1.003	0.188
	Negative results	Ref	-	-
Heard/Know Schistosomiasis	No	1.840	1.295-2.615	0.001*
	Yes	Ref	-	-
Observed signs in a tent/room member	No	0.602	0.425-0.855	0.005*
	Yes	Ref	-	-
Major water source	Open water-body	21.255	10.164-44.450	0.000*
	Pipe/tap	1.701	0.668-4.333	0.265
	Well/borehole	Ref	-	-
Bathed/washed in an open water source	No	0.683	0.481-0.969	0.033*
	Yes	Ref	-	-

*****=Significantly different, **CI**=confidence interval, **OR**=Odds ratio, No.=Number

The table shows the variables that significantly (p<0.05) influenced the presence of infection in the study population in the final model. The Hosmer-Lemeshow goodness of fit test showed that the model significantly fitted the data (χ^2 = 12.588, df=8, p=0.128). The Chi-squared test for independence shows no significant association among the independent variables examined. The final model revealed only seven of the factors investigated remained statistically significant (p<0.05) predictors of urinary schistosomiasis among the IDPs when all the studied factors were taken into consideration. These statistically significant factors included sex of the respondents, their occupation (χ^2 = 9.873, df=4, p=0.04), whether or not the respondent participated in water sporting activity before displacement, their major source of water supply before displacement (χ^2 = 72.484, df=2, p<0.001), whether or not the respondent observed signs of the disease in members of their tent/room, whether or not the respondent knows about the disease and whether or not the respondent has been washing/bathing in open water body before displacement. Other factors include the LGA of residence of respondents (χ^2 = 16.730, df=3, p=0.001) and their major source of water supply (χ^2 = 72.467, df=2, p<0.001) before the displacement. However, educational background, Local Government of residence before displacement, the distance of residence from open waterbody and the number of children per room/tent in the camp were not statistically significant but were included in the final model.

4. Discussion

The brutal displacement of the population by Boko Haram has negative impacts on healthcare delivery in the north-eastern part of Nigeria. Bearing in mind the conditions in the IDP camps, it is expected that the threat of contamination of surrounding water bodies is imminent due to the inadequate toilet facilities in the camps. This is considered to be aggravated by poverty and limited sanitation (Weerakoon, et al. 2015) as presently observed in the camps. Control of the problem in the camps may prove ineffective so long as these underlying issues are not tackled. Water contamination with urine reflects human behaviour and this often seems remarkably resistant to change, despite efforts to improve sanitation and educate school children on the basics of the schistosome life cycle and basic hygiene (Rollinson, et al., 2013). Also, infection with *S. haematobium* is known to decrease bladder elasticity and increase the frequency of urination.

The gold standard diagnostic technique, urine microscopy was employed in this study in which the overall prevalence of urinary schistosomiasis was 21.9% among the study population. This prevalence rate can be considered to be moderate based on the WHO (WHO, 2002) report that classified schistosomiasis prevalence rates from 0.1-9.9% as low, 10.0-49.9% as moderate and 50% and above as high. The prevalence rate obtained in this study is nearly equal to the 21.4% reported among school children from the White Nile Province of the Republic of Sudan (Ismail, et al., 2014). The prevalence in this study was however higher than some previously reported rates in Nigeria; where an overall prevalence of 15.3% was reported in Ebonyi (Ivoke, et al., 2014), 17.8% in Kano (Dawaki et al., 2016), 17.4% in Oyo (Okoli & Odaibo, 1999), 18.7% in Plateau and Nasarawa (Evans, et al., 2013) and 15.7% from Anambra (Ugochukwu, 2013). On the contrary, the overall prevalence rate reported in this study was observed to be lower than the 35% reported in children examined from Gusau, Zamfara State, Nigeria (Bala, et al., 2012), 48.7% in out-of-school children in Dikwa Local Government Area, Borno state (Baba, et al., 2015.) and 44.2% in Kano (Duwa, et al., 2009). The disparities observed could be attributed to the differences in demography and socioeconomic reasons. In this study, the target population was made up of IDPs of various age groups while the target population in the previous studies were children. Likewise, the higher prevalence in the previous studies could also be attributed to the fact that school-age children are more vulnerable to urinary schistosomiasis infection due to frequent contact with contaminated water and poor hygiene (Bala, et al. 2012: Deribe, et al., 2011).

The logistic regression analysis in this study showed a significant association between infection and sex, which showed the odds of the disease is higher in males compared to females. Similar findings were reported by (Biu et al., 2009), (Bala et al., 2012), (Invoke et al., 2014) and (Dawaki et al., 2016) where the rate was found to be significantly higher in males compared to females. Our finding was however observed to have contradicted the reports of (Okanla et al., 2003) who reported a higher rate in females (35.8%) compared to males. This disparity could still be attributed to demographic variability in the study population since the previous study (Okanla et al., 2003) involved individuals residing within their local communities while this study involved people displaced from their ancestral homes who were exposed to higher risks of infection occasioned by the immunosuppression induced by the stress of the displacement.

Respondents that bathed and or washed in open water bodies had higher risks of being infected compared to those that do not. Individuals that reside close to open water bodies are prone to having frequent contact with water for recreational or occupational activities through drinking, bathing, swimming and washings that constitute potential risks for transmission of the disease. The location of residents from open water sources was not a significant predictor but was included in the final model. This may be explained by observations from a previous report from South Africa (Kabuyaya, et al., 2017) who opined that respondent whose homesteads were close to open water sources were more likely to contract *Schistosoma* infection compared to those residing further away. It is believed that the proximity of the homesteads to open water sources may facilitate frequent contact with the water. The open water source may serve as means of transportation in addition to being used for water-based sports, household and trade needs. These may lead to increased water-contact time in the given community thereby increasing chances of infection with *Schistosoma* (Abdulkadir, et al., 2017). The finding in this study also agrees with findings from previous studies (Kabuyaya, et al., 2017: Ogefere & Osuolale, 2017: Sady, et al., 2013) who also reported that frequent contact with water poses a significant risk for the occurrence of schistosomiasis. This study showed that educational attainment may not be a risk factor but may be important in the prediction of schistosomiasis in the study population. Even though educational attainment is not a statistically significant factor based on our final model, it is considered to be an important predictor of the occurrence of the disease, thus its inclusion. This is especially true since knowledge of the disease was found to be a significant factor influencing infection. This is due to the notion that respondents with low educational attainment may be at a higher risk of acquiring schistosomiasis compared to those with a higher level of educational attainment. This is also supported by the WHO assertion that there is an increased risk of acquiring schistosomiasis among non-educated individuals in a given community consequent of the low socio-economic and educational attainment in such communities (World Health Organization, 2010). This study showed that the occupation of the respondent is not a statistically significant factor based on our final model. This may be because some occupations involved frequent contact with contaminated water thereby increasing the risk of acquiring infection over time. This is supported by the findings by (Ugochukwu, 2013) who reported that farmers were significantly at greater risk of *Schistosoma* infection compared to other occupations. In the same vein, the local government of residence before displacement was not a statistically significant factor based on the final model but was considered to be an important predictor of the occurrence of the disease. The risk of infection was slightly lower in respondents from Bama, Damboa and Gwoza compared to those from Konduga. The respondents from Konduga may have had more frequent contact with the contaminated water sources before the displacement. In most rural settings, there is an inadequate potable water supply that may force people to use open water sources that are mostly contaminated with human waste (Abdulkadir, et al., 2017). This was further supported by the finding in this study that showed a significant statistical association between infection and the respondent's sources of water supply before the displacement. Therefore, we suspect that most of the infections diagnosed in this study might have been acquired before displacement. The risk of infection in respondents who observed signs of the disease in members of their tent/room were significantly higher than those who do not. This may be because people who share a tent/room are usually from the same or closely related family and might have acquired the infection through a common source. This is true especially in villages that lack clean water sources. It should be noted that the estimates and risk factors reported in the study may be generalized for the population since the minimum required sample size was exceeded.

5. Conclusion

It can, therefore, be concluded from this study that the overall prevalence of urinary schistosomiasis in the study area was 21.9%. Variables that included knowledge of the disease, source of water supply before displacement, presence of signs of the disease in a tent/roommate and bathing/washing in an open water source before displacement were found to have significantly influenced the occurrence of the disease in the respondents.

Control of urinary schistosomiasis is primarily based on measures that mitigate water contact practices, improved human waste disposal and health-seeking practices. The use of schistosomicides and molluscicides should be the backbone of most national control programmes (WHO, 2002: WHO, 2010: Lo, et al., 2018). Going by the identified risk factors such as a source of water supply, sex, contact with open water sources and knowledge of the disease, other effective control measures recommended should include behavioural changes, public health enlightenment campaign, sanitation and safe water supply.

The limitations of this study are inadequate molecular biology facilities to further characterise and investigate the schistosome eggs detected in our study to compare the genetic sequence with others reported elsewhere thereby providing detailed molecular epidemiology of the disease agent. In addition, further investigation on other schistosomes and zoonotic parasitic infections be carried out among the IDPs to provide a better understanding of their disease burden.

What is already known on this topic:

- Urinary schistosomiasis is a water-borne parasitic zoonosis of worldwide distribution.
- It has high socio-economic impacts on impoverished communities and competes with other diseases for the allocation of scarce health care resources.

What this study adds:

- Schistosomiasis is present in both male and female of all ages of the inhabitants of the IDP camps in Maiduguri and the infection affect all ages and sexes.
- Gender, occupation, knowledge of the disease, presence of infection in close contact, source of water supply and water contact behaviours such as involvement in water sports, and use of surface water source for domestic uses influenced the presence of infection in this study.
- Behavioural changes, improved sanitation and safe water supply will help in reducing the burden of the disease in the study population.

6. Declarations

Ethics approval and consent to participate:
Ethical clearance was sought before the commencement of the study and the approval was granted by the Borno State Ministry of Health (MoH) and State Emergency Management Agency (SEMA) with certificate No.: Ref. No. MOH/BOS/S/1005/Vol.I/54. Written informed consent was obtained from each of the respondents. In case children or minors, consents of their parents

or legal guardians were obtained before they are recruited into the study.

Availability of data and materials:
The datasets used and analysed in this study are available from the corresponding author on request.

Competing interests:
The authors declared they have no competing interests.

Funding:
The authors did not receive support from any organization for the submitted work.

Authors' contributions:
All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Hassan Ismail Musa, Adamu Saleh Saidu, Muhammad mamman Gashua and Muhammad Abubakar. The first draft of the manuscript was written by Hassan Ismail Musa, Abdulyeken Olawale Tijjani and Abubakar Sadiq Muhammad. All authors commented on previous versions of the manuscript and participated in reviewing it to the present version. All authors read and approved the final manuscript. Co.

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	7
		(*e*) Describe any sensitivity analyses	8
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	9-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10
		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.