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Risk Factors Associated with Urinary Schistosomiasis and Its Spatial Distribution Among Male Children in Selected Communities in Shinkafi, Zamfara State, Nigeria

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Abstract

Urinary schistosomiasis is a chronic disease caused by Schistosoma haematobium, which is endemic in Nigeria and is attributable to poverty, particularly in resource-constrained populations. This study assessed the prevalence and risk factors associated with urinary schistosomiasis among male children in Shinkafi, Badarawa, Jangeru, and Katuru Areas of Shinkafi Local Government, Zamfara State, Nigeria. A cross-sectional study was conducted across the four (4) communities from July to November 2023. A structured questionnaire was used to collect the socio-demographic data of the participants. Five hundred and fifty-one (551) urine samples were collected and examined for the ova of Schistosoma haematobium using the centrifugation technique. The prevalence of the infection in the study communities is 42.8%. Jangeru community had the highest prevalence of 56.6%, then Shinkafi with a prevalence of 47.2%, followed by Badarawa with a prevalence of 36.6%, and Katuru with the lowest prevalence rate of 24.0%. The study confirmed a high prevalence of schistosomiasis in the studied area. The study identified factors such as closeness of the water bodies, age, and history of praziquantel treatment usage as the risk factors for schistosomiasis in the study area. The study suggests that improved environmental sanitation, water control measures, hygiene, implementation of regular mass deworming of infected male children, and public enlightenment should be highly sustained to lower the prevalence of urinary schistosomiasis in the study area.

Keywords: Haematuria, Praziquantel, Prevalence, Dysuria, Insecurity

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INTRODUCTION

Urinary schistosomiasis, sometimes referred to as Bilharziasis, is a neglected tropical disease (NTD) caused by dioecious blood fluke (digenetic trematode) belonging to the genus Schistosoma (Atalabi *et al*., 2018). It is classified as the second most economically and socially devastating parasitic illness, following malaria. It is the most common waterborne disease among rural populations (Atalabi *et al*., 2018). The parasite is spread through infected freshwater snails of *Balinus* spp (Nalado *et al*., 2021), whereas humans of all age groups serve as the final host (Uchendu *et al*., 2017). Approximately 700 million individuals reside in regions where the disease is prevalent. Therefore, roughly 200 million individuals are infected with the disease in 76 countries worldwide, with the highest rates of infection found in sub-Saharan Africa and some parts of Asia (Auta *et al*., 2020). Nalado *et al*. (2021) reported that the disease is endemic in many countries in the Middle East and Africa, about 436 million people are at risk and 112 million are infected in sub-Saharan Africa. About 70 million various environmental and socioeconomic factors contribute to the ongoing prevalence of Bilharziasis in children. The contributing factors encompass unsanitary environments, absence of potable water, inadequate housing, unhygienic practices, and poverty (Amuta and Houmsou, 2014). These circumstances result in continued exposure to the causative parasites and elevated illness rates.

Nigeria is a highly endemic country for schistosomiasis, with an estimated 101.28 million individuals at risk and 25.83 million affected (Nalado *et al*., 2021). In certain instances, it has the potential to result in the development of secondary conditions such as renal impairment and malignancy. Additional health consequences linked to the disease include a heightened likelihood of anaemia, bladder cancer, inadequate nutrition, delayed onset of puberty in children, hindered growth in children, and impaired cognitive development in infected individuals. Furthermore, the disease is known to reduce physical activity, hinder school performance, limit work capacity, and decrease productivity (Nalado *et al*., 2021).
Parasite eggs are identified in urine specimens to diagnose schistosomiasis. Antibodies and/or antigens detected in blood or urine samples indicate infection. A filtration technique that employs nylon, paper, or microscopic detection of blood in urine by chemical reagent strips is employed for urogenital schistosomiasis (Kikelomo *et al*., 2022). School-age children are believed to have regular exposure to water, which increases their susceptibility to schistosomiasis. As a result, they are more commonly affected by schistosomiasis issues. Hence, the study investigated the epidemiology and risk factors associated with urinary schistosomiasis among male children in Shinkafi Local Government Area of Zamfara State, Nigeria.

MATERIALS AND METHODS

Study Design

A randomized cluster design and a cross-sectional study approach of urine sample collection was conducted among children of the selected areas in the Shinkafi Local Government Area of Zamfara State between July and November 2023.

Study Area

The study was conducted in four (4) communities in the Shinkafi Local Government of Zamfara State, Nigeria ($13^0 02'$N $6^0 31'$E). Its headquarters is located in the town of Shinkafi, which covers an area of around 674 km^2 and has a population of 135,649 (NPC, 2006). The area is bordered by Isa Local Government Area (Sokoto State) and Niger Republic to the north, Zurmi Local Government Area to the south and southeast, and Maradun Local Government Area and Raba Local Government Area (Sokoto State) to the west (Fig. 1). The four selected communities are Shinkafi, Badarawa, Jengeru, and Katuru. Their proximity to water bodies determined the choice of such areas.

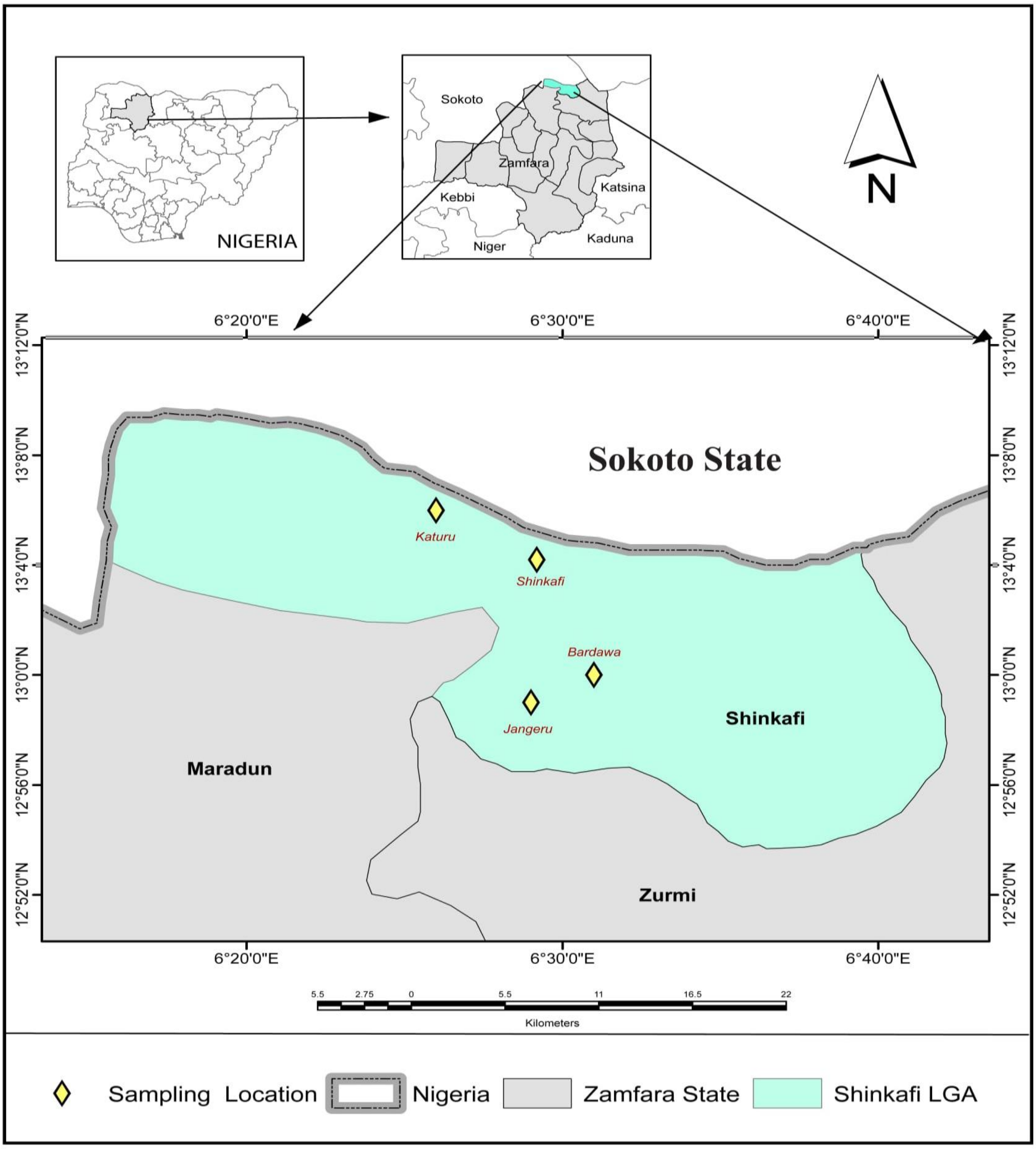

Figure 1: Map showing sampling locations within Shinkafi Towns (adapted from the open street map and Google Earth Imagery 2023)

Sample Collection

Urine samples were obtained from the children recruited across the areas selected for this study. About 20 mL of urine sample was collected into a sterile corked plastic tube from each child between the hours of 10:00 am – 02:00 pm and labeled appropriately. The collected samples were placed in a dark polyethylene bag kept cool in ice-packed containers, and then transported to the laboratory for further analyses.

Sample Size Determination

The sample size for the study was determined using the single proportion formula described by Dawet *et al.*, 2012, also used in previous studies (Auta *et al.* 2020; Nalado *et al.*, 2021), assuming a 21.3% proportion of urinary schistosomiasis.

$$n = \frac{Z^2P(1-P)}{d^2}$$

Where;

n = Sample Size

Z = Statistical corresponding to level of confidence = 1.96 for 95% confidence level interval

P = Expected prevalence based on previous studies = 55% = 0.55 (Auta *et al.* 2020).

(1-P) = Probability of failure

d = Absolute error of degree of precision = 5% = 0.55

Therefore,

$$n = \frac{(1.96)^2(0.55)(0.45)}{0.55^2} = 380.32$$

The minimum sample size is 380 using a tolerable error of 5%. However, for this work, 45% of the sample size was added to increase precision. A total of 551 samples were used for this study.

Ethical Consideration and Advocacy

The State Ministry of Health Ethical Clearance Committee reviewed and approved the study protocol in Zamfara State. Informed consent was obtained from the Emir of Shinkafi of those who were selected for the study. Those who did not consent or were unwilling to participate were not included in the study. Participants were also given the liberty to withdraw from the study at any time.

Physical Examination of the Urine Samples

The samples collected were physically examined to determine their color and turbidity. They were categorized and documented as cloudy/dark (may indicate dehydration), brown/red (may indicate the presence of blood), clear/pale yellow (may indicate the presence of bilirubin), and green (may indicate the presence of pseudomonas infection) appearances (Nalado *et al.*, 2021). These data were recorded appropriately in the urinalysis form.

Urine Microscopy

To examine the urine samples for the eggs of *S. haematobium*, all the urine samples were mixed and 10 mL of each was transferred to a clean centrifuged tube and spun at 1500 revolutions per minute (rpm) for 5 minutes using a C2 series Centurion Scientific Centrifuge (Sussex, United Kingdom). The resulting sediment was examined under a compound (binocular) microscope (Motic™ Wetzlar, Germany) using x10 objective lens. The presence of the ova of *S. haematobium* was confirmed by identifying their distinctive terminal spine using x40 objective lens (Cheesbrough, 2006).

Questionnaire

Data were collected from children and community healthcare providers using a semi-structured questionnaire. The purpose was to gather information on water contact and control activities in the community. The data was collected to assess the effects of National control interventions on these healthcare providers who worked in the communities. The questionnaires administered to the children gathered information regarding their demographic details such as age, presence of haematuria, and engagement in water-related activities. On the other hand, the questionnaires given to the healthcare providers focused on their understanding of diseases affecting the community, treatment methods employed, strategies for preventing schistosomiasis infections, and obstacles hindering control and elimination efforts.

Data Analysis

Data analysis was conducted using Statistical Package for Social Science (SPSS) software. Chi-square and Fisher's Exact Test were also used where applicable at 95% confidence interval and 0.05 level of significance. P-values of ≤ 0.05 were considered statistically significant.

RESULTS AND DISCUSSION

The study encompassed a total of 551 children. Among the communities, Shinkafi had a larger number of sampled children, 254 (47.2%), compared to other communities. Katuru had 100 samples with a prevalence of urinary schistosomiasis at 24.0%, Badarawa had 98 samples with a prevalence of 36.7%, and Jangeru had the highest prevalence at 56.6% (Table 1).

Table 1: **Prevalence of Urinary Schistosomiasis by Community**

Community	NE	NI	Pr. (%)
Shinkafi	254	120	47.2
Katuru	100	24	24.0
Jangeru	99	56	56.6
Badarawa	98	36	36.7
Total	551	236	42.8
$\chi2$			25.6170
P-value			< 0.0001

NE=Number of Examined, NI=Number of Infected, Pr.=Prevalence

Results presented in Table 2 show the prevalence of urinary schistosomiasis by age group. The age group 11-15 years had the highest prevalence (55.4%), the age group 16-20 years had the lowest prevalence (20.2%) and the age group 5-10 had a moderate prevalence of (50.0%).

Table 2: Prevalence of Urinary Schistosomiasis by Age Group

Age (Years)	NE	NI	Pr. (%)
5 – 10	42	21	50.0
11 – 15	316	175	55.4
16 – 20	193	40	20.2
$\chi2$			59.896
P-value			< 0.0001

NE=Number of Examined, NI=Number of Infected, Pr.=Prevalence

The risk factors associated with urinary schistosomiasis infections among the participants in this study include; age, gender, and other demographic factors, exposure to contaminated water bodies, poor sanitation and hygiene, living in endemic areas, occupational-related exposures such as fishing, swimming, etc., and engagement in recreational activities in large water bodies (Table 3). These factors were consistently identified across multiple studies as significant predictors of schistosomiasis infection or its prevalence (Atalabi *et al*., 2018; Auta *et al.* 2020; Nalado *et al*., 2021).

Table 3: Risk Factors of Urinary Schistosomiasis among Male Children in Shinkafi Local Government Area

Category	NE	NI	Pr. (%)
Source of water			
Well	54	10	18.5
River	17	8	47.1
Tap	325	88	27.1
Ponds/Lakes	140	117	83.6
Others	15	13	86.7
$\chi 2$			152.772
P-value			<0.001
Exposure to water bodies			
Yes	534	232	43.4
No	17	4	23.5
$\chi 2$			2.669
P-value			0.102
Type of Water Body			
Well	127	15	11.8
River	16	4	25.0
Tap	187	21	11.2
Ponds/Lakes	219	194	88.6
$\chi 2$			315.860
P-value			0.001
Purpose of visit			
Fetching water	281	33	11.7
Bathing/swimming	209	187	89.5
Fishing	12	7	58.3
Others	46	7	15.2
Not applicable			
$\chi 2$			312.33
P-value			0.001

NE=Number of Examined, NI=Number of Infected, Pr.=Prevalence

The participants who passed bloody urine have a higher prevalence (86.9%) than those who never passed blood in urine. While those with no history of praziquantel treatment had a higher prevalence (76.8%) than those who took praziquantel treatment (Table 4).

Table 4: Haematuria, history of Praziquantel treatment, and urinary schistosomiasis among male children in Shinkafi Local Government Area.

Haematuria	NE	NI	Pr. (%)
Yes	160	139	86.9
No	391	97	24.8
$\chi 2$			178.62
P-value			0.0001
Praziquantel history			
Yes	325	63	19.4
No	224	172	76.8
$\chi 2$			179.68
P-value			<0.001
When last (Months)			
1	55	7	12.7
2	48	9	18.8
6	124	8	6.5
Can't remember	102	44	43.1
Never	222	168	75.7
$\chi 2$			196.55

NE=Number of Examined, NI=Number of Infected, Pr.=Prevalence

Prevalence of urinary schistosomiasis among male children in Shinkafi Local Government Area

The overall prevalence of urinary schistosomiasis among male children in this study was 42.8%. The prevalence rate in the study localities falls within the moderate-risk range (<50) based on the national prevalence range of Nigeria (Nduka *et al.,* 2019). The occurrence of urinary schistosomiasis in this study corroborates previous findings from studies conducted in Katsina, Kaduna, and Sokoto in Nigeria, as well as Maiduguri in the northeast region of Nigeria (Auta *et al.,* 2020; Nalado *et al*., 2021; Doudou *et al*., 2022; Gamde *et al*., 2023).

In comparison, infection with *S. haematobium* was more prevalent in Jangeru (56.6 %), than in Shinkafi (47.2%), Badarawa (36.7%), and Katuru (24.0%), (Table 1). The high prevalence reported in this study is quite higher than the 31.7% prevalence reported among school children in Dutsinma (Nalado *et al*., 2021), 30.0% in Zamfara (Mudassiru *et al.,* 2018), 21.3% among vulnerable children in security challenged district of Safana (Auta *et al.*, 2020), and also lower than the 37% prevalence reported by Iduh and Bwari (2021) in Sokoto.

Furthermore, the current prevalence of urinary schistosomiasis in Shinkafi corresponded to the study held in the same area in 2020 by Bala *et al.* (2020). The occurrence prevalence of *S. haematobium* infection in Shinkafi town may be attributable to the larger number of water bodies in the area (Figure 2).

On the other hand, Jangeru recorded the highest prevalence of infection (56.6%), which classified the community as a high-risk area among the community studied, and the lowest prevalence (24.0%) was recorded in the Katuru area (Table 1). Analyzed risk factors for the infection with *S. haematobium* in this survey include sourcing water from the ponds/stream, which had a higher prevalence (88.6%) than those that sourced water from taps (11.2%), frequent contact with large water bodies also had a higher prevalence (43.4 %), than those who didn't have contact with water bodies (23.5%), (Table 3). The age group 11-15 years had the highest prevalence (55.4%), while the age group 16-20 years recorded the lowest prevalence (20.0%). *Schistosoma haematobium* infection was significantly associated with the age group ($\chi2$=59.896, P=0.0000) (Table 2).

Participants who passed bloody urine recorded a higher prevalence (86.9%) than those who never passed blood in the urine (24.8%), infection with *S. haematobium* was significantly associated with passing bloody urine ($\chi2$=178.62, P= 0.0000). The presence of blood in the urine (haematuria) is a common symptom of urinary Bilharziasis (Knopp *et al,* 2018). Similarly, those without a history of praziquantel treatment recorded a higher prevalence (79.6.2%) than those who took praziquantel treatment (17.4%) (Table 5). These findings are in tandem with previous studies that reported cultural practices and socio-economic variables among the risk factors for the transmission of urinary schistosomiasis in Nigeria (Amuta *et al*., 2014; Gamde *et al*., 2023).

CONCLUSION

In conclusion, the study has reported a high prevalence of schistosomiasis among male children in Shinkafi Local Government Area in Zamfara State. Significant risk factors of this disease in the area included age, water source, frequent contact with water bodies, and lack of access to the praziquantel treatment, and they contribute to its persistence. These findings highlight that urinary schistosomiasis remains a major health concern, necessitating urgent and effective medical interventions.

Looking ahead, further research should encompass a broader demographic to provide comprehensive data on the prevalence and risk factors of urinary schistosomiasis in the region. Expanding regular mass deworming programs for male children is essential to reduce the disease's prevalence. Ensuring access to clean water, regularly monitoring water sources for snail intermediate hosts, and treating them with molluscicides are critical steps. Additionally, launching public education campaigns to raise awareness about the risks and transmission of urinary schistosomiasis can encourage better environmental sanitation and personal hygiene practices, ultimately preventing the further spread of the infection.

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CRediT Authorship Contribution Statement
Surajo Yahaya Shinkafi conducted laboratory analyses and wrote the initial draft of the manuscript. Tolulope Ebenezer Atalabi contributed to writing the draft manuscript. Timothy Auta performed the data analysis and also contributed to writing the draft manuscript. Nalado Yusuf Ahmed contributed to the manuscript's data retrieval, writing, review, and editing. The final version of the manuscript was reviewed and approved by all authors.

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