

Epidemiology and Risk Factors of Urinary Schistosomiasis Among Residents Within Dallaje Reservoir, Bindawa Local Government, Katsina State, Nigeria

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ABSTRACT

Schistosomiasis remains a major neglected tropical disease and a leading cause of morbidity in sub-Saharan Africa. *Schistosoma haematobium*, transmitted via freshwater snails, is responsible for urinary schistosomiasis, with school-aged children being the most vulnerable. This study assessed the prevalence and predictors of urinary schistosomiasis among residents near the Dallaje Reservoir, Katsina State, Nigeria. A cross-sectional survey was conducted among 392 schoolchildren aged 7–15 years. Socio-demographic data were collected using pre-tested questionnaires. Urine samples were examined for *S. haematobium* eggs by sedimentation, and statistical analysis was performed using chi-square tests with significance set at $p \leq 0.05$. The overall prevalence of urinary schistosomiasis was 28.6%. Infection was detected exclusively in males (46.7%), while no cases were recorded among females (0%), reflecting significant gender disparity ($p < 0.0001$). Age-specific prevalence was highest among children aged 13–15 years (37.6%). Children of working-class parents were significantly more affected ($p < 0.0001$), likely due to reduced supervision. No association was found between parental education and infection ($p = 0.5867$). Engagement in water-related activities such as swimming, fishing, and irrigation was strongly linked with infection risk ($p < 0.0001$). Urinary schistosomiasis remains highly prevalent around the Dallaje Reservoir, with transmission strongly influenced by gender, age, parental occupation, and water-contact behaviors. The absence of infection in females highlights cultural practices that limit exposure. Control strategies should prioritize gender-sensitive interventions, improved water and sanitation access, and targeted health education for at-risk populations.

Keywords: *Schistosoma haematobium*, urinary schistosomiasis, prevalence, risk factors, schoolchildren.

1.0 INTRODUCTION

Schistosomiasis is a major neglected tropical disease that ranks second only to malaria in terms of global health impact (Colley *et al.*, 2014; McManus *et al.*, 2018). The disease is caused by trematodes of the genus *Schistosoma*, with *S. haematobium* responsible for urinary schistosomiasis and *S. mansoni* for intestinal schistosomiasis. Transmission occurs through contact with freshwater containing cercariae released by infected snails, primarily *Bulinus* species for *S. haematobium* (Manyangadze *et al.*, 2016).

Globally, more than 230 million people are infected, with 700 million at risk (Angelo *et al.*, 2018; Dawaki *et al.*, 2016). Sub-Saharan Africa bears about 90% of the burden, and Nigeria alone accounts for an estimated 29 million cases and over 100 million people at risk (Amuta & Houmsou, 2014; Odeniran *et al.*, 2020). The disease disproportionately affects school-aged children due to frequent contact with infested water bodies and limited awareness of preventive practices (Houmsou *et al.*, 2016; Gordon *et al.*, 2019).

Transmission dynamics are shaped by poverty, inadequate sanitation, and dependence on unsafe water sources (Aagaard-Hansen *et al.*, 2009; Steinmann *et al.*, 2006). Water-related activities such as swimming,

fishing, irrigation, and washing clothes facilitate continuous exposure (Utzinger *et al.*, 2011; McCreesh *et al.*, 2015). Studies in Nigeria and across Africa show gender disparities, with boys more frequently infected due to greater involvement in outdoor water activities, while cultural restrictions reduce female exposure (Senghor *et al.*, 2014; Ahmed *et al.*, 2021; Abubakar *et al.*, 2022). Despite numerous prevalence studies, risk factor patterns vary across ecological settings and remain poorly understood in many local contexts.

Katsina State in northwestern Nigeria is endemic for schistosomiasis, with multiple water bodies serving as transmission foci. Recent studies report substantial prevalence among children in surrounding communities (Dawaki *et al.*, 2016; Ahmed *et al.*, 2021). However, there is limited information on the predictors of urinary schistosomiasis around the Dallaje Reservoir in Bindawa Local Government Area, a site where children's daily contact with water through farming and recreation may sustain transmission. Addressing this gap is essential for designing context-specific interventions.

Previous studies across Africa have consistently shown high prevalence of *S. haematobium* among school-aged children. For example, Coulibaly *et al.* (2013)



highlighted the burden in preschool children in Côte d'Ivoire, while Kabuyaya *et al.* (2017) identified environmental and behavioral risk factors in South Africa. In Nigeria, Houmsou *et al.* (2016) demonstrated spatial heterogeneity in the northeast, and Dawaki *et al.* (2016) emphasized socio-cultural factors in Hausa communities of Kano State. More recent studies, such as Ahmed *et al.* (2021) in Katsina, reported gender-specific infection patterns, with males disproportionately affected.

While these works provide valuable insights, most are descriptive prevalence surveys with limited analysis of predictors across varying socio-demographic groups. Few studies examine the combined influence of parental occupation, educational background, and specific water-contact behaviors on local transmission. Consequently, there is a need for focused research that integrates epidemiological data with socio-behavioral determinants at community level. The present study addresses this gap by analyzing risk factors specific to children living around the Dallaje Reservoir.

1.4 Aim and Objectives

This study aimed to determine the prevalence and predictors of *Schistosoma haematobium* infection among school-aged children around the Dallaje Reservoir, Katsina State. The specific objectives were to:

1. Assess the prevalence of urinary schistosomiasis among children in the study area.
2. Identify socio-demographic and behavioral risk factors associated with infection.
3. Provide evidence to guide locally adapted control strategies and inform public health interventions.

1.5 Hypotheses

Based on prior evidence, the study was guided by the following hypotheses:

- a) **H1:** Male children are more likely to be infected with urinary schistosomiasis than female children due to differential water-contact activities.
- b) **H2:** Children of working-class parents have a higher prevalence of infection than those of non-working parents, owing to reduced supervision.
- c) **H3:** Engagement in water-related activities such as swimming, fishing, and irrigation is positively associated with *S. haematobium* infection.
- d) **H4:** Parental educational background has no significant influence on children's risk of infection.

1.6 Significance of the Study

Understanding the epidemiology of urinary schistosomiasis in Dallaje is critical for refining school-

based deworming, improving water and sanitation interventions, and informing surveillance systems. By clarifying local risk factors, this study contributes to national and regional efforts toward schistosomiasis control and aligns with global elimination targets.

2.0 MATERIALS AND METHODS

2.1 Participant (Subject) Characteristics

The study population comprised school-aged children (7–15 years) enrolled in four primary schools located in communities surrounding the Dallaje Reservoir, Bindawa Local Government Area (LGA), Katsina State, Nigeria (12°40'11"N, 7°48'19"E). The area is predominantly Hausa–Fulani, with major occupations being farming, trading, and animal rearing.

Data collection was conducted between December 2023 and July 2024 during weekdays (Monday–Friday), with a minimum weekly target of 40 participants. Children were eligible if they were within the specified age range, enrolled in the selected schools, and provided both parental consent and individual assent. Exclusion criteria included children with severe illness at the time of data collection or those who declined participation.

2.2 Sampling Procedures

A school-based survey design was used. Four schools were purposively selected for their proximity to the Dallaje Reservoir: Dallaje Model Primary, Faru Primary, Nasarawa Primary, and Rugar Jabe Primary. Within each school, participants were selected using systematic random sampling from class registers to ensure representation across grades. On designated survey days, children absent from school were not replaced.

2.3 Sample Size, Power, and Precision

Sample size was calculated using the single-population proportion formula recommended by WHO (Naing *et al.*, 2006):

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

where:

- a) **N** = required sample size
- b) **Z** = standard normal deviate at 95% confidence interval (1.96)
- c) **P** = expected prevalence (37.8% or 0.378) (Usman *et al.*, 2019)
- d) **d** = degree of precision (0.05)
- e) **1 - P** = probability of failure (1 - 0.378 = 0.622)

The sample = 361.28

Assuming an expected prevalence of 37.8% (Usman *et al.*, 2019), a 95% confidence level ($Z = 1.96$), and a precision of 5%. The minimum required sample was 361.28. To compensate for potential non-response, the sample was increased by 10.8%, yielding a target of 400 participants.



A total of 392 children completed both the questionnaire and laboratory procedures, corresponding to a response rate of 98%. This sample size provided >80% power to detect gender-based prevalence differences of 10% or greater at $\alpha = 0.05$.

2.4 Measures and Covariates

Outcome measure: The primary outcome was infection with *Schistosoma haematobium*, defined as the presence of characteristic eggs with terminal spines in urine.

Laboratory analysis: Urine samples (collected between 09:00 and 12:00 hours) were analysed using the sedimentation method (Cheesbrough, 2005). Ten millilitres of urine were centrifuged at 2,000 rpm for 5 minutes, the supernatant discarded, and the sediment examined under $\times 10$ and $\times 40$ objectives. Lugol's iodine was applied to enhance visualization. Results were expressed as eggs per 10 mL urine. Each slide was independently read by two trained microscopists; 10% of slides were re-examined by a senior parasitologist for quality control. Urine was also inspected for visible haematuria and proteinuria.

Covariates: Socio-demographic and behavioural data were collected through a structured questionnaire. The following predictors were assessed:

- Age group:** 8–10, 11–12, and 13–15 years.
- Gender:** male or female.
- Parental occupation:** coded as “working” if at least one parent engaged in employment outside the household, “not-working” otherwise.
- Parental education:** classified as “formal” (\geq primary school education) or “non-formal.”
- Water-contact activities:** self-reported engagement in drinking, washing, swimming, fishing, irrigation, or crossing water bodies. Children reporting two or more activities were grouped under “at least two activities.”

2.5 Research Design

This was a **cross-sectional analytical study** designed in accordance with the STROBE guidelines for observational research (von Elm *et al.*, 2007).

Ethical approval: Approval was obtained from the Katsina State Ministry of Health (Reference No.: MOH/ADM/SUB/1152/1/2829, dated 11 December 2023). Permissions were also granted by the Local Government Education Authority and participating schools. Written informed consent was obtained from parents/guardians, and child assent was secured prior to enrolment. Participation was voluntary, with the option to withdraw at any time.

3.0 STATISTICAL ANALYSIS

Data were entered and cleaned before analysis in GraphPad Prism version 3.06 (GraphPad Software, San Diego, CA, USA). Prevalence was calculated with 95% confidence intervals (CIs). Associations between schistosomiasis and categorical predictors were assessed using chi-square tests. To identify independent predictors, binary logistic regression was planned; variables with $p < 0.20$ in bivariate analysis were entered into the multivariable model. Results were expressed as odds ratios (ORs) with 95% CIs, and statistical significance was set at $p \leq 0.05$.

3.1 Experimental Manipulations or Interventions

No experimental interventions were performed. However, ethical considerations required treatment of infected participants. All children who tested positive were referred to local health authorities and treated with praziquantel (40 mg/kg body weight, single dose) in line with national schistosomiasis control policy. School health authorities were also notified to facilitate follow-up during subsequent mass drug administration campaigns.

4.0 RESULTS AND DISCUSSION

4.1 Results

4.1.1 Prevalence of Urinary Schistosomiasis

A total of 392 schoolchildren aged 7–15 years participated in the study. The overall prevalence of urinary schistosomiasis was **28.6% (95% CI: 24.3–33.2)**. Males accounted for the entirety of infections, yielding a striking gender disparity. Of 240 males examined, 112 were infected (**46.7%; 95% CI: 40.3–53.2**), while none of the 152 females tested positive. The association between gender and infection was highly significant ($\chi^2 = 95.22$, $p < 0.0001$).

4.1.2 Age-Related Patterns

Age-specific prevalence showed highest infection among children aged 13–15 years (**37.6%**), followed by those aged 8–10 years (**30.6%**), while 11–12-year-olds recorded **25.9%** (Table 1). The overall association between age group and infection was not statistically significant ($\chi^2 = 2.93$, $p = 0.2325$). However, the observed gradient suggests increasing vulnerability during early adolescence.

Table 1: Prevalence Of *Schistosoma Haematobium* Infection By Gender And Age Group (N = 392)

Variable	No. Screened	No. Infected	Prevalence (%)
Gender			
Males	240	112	46.7
Females	152	0	0
Age Group (years)			
8–10	98	30	30.6
11–12	243	63	25.9

Variable	No. Screened	No. Infected	Prevalence (%)
13–15	51	19	37.6
Total	392	112	28.6

School	No. Examined	No. Infected	Prevalence (%)	Mean Egg Count/10ml
Total	392	112	28.6	32.24

4.1.3 School-Specific Prevalence

Infection prevalence varied by school (Table 2). Nasarawa Primary School reported the highest prevalence (**36.7%**) and mean egg count (**41.0 eggs/10 mL**), while Dallaje Model Primary had the lowest prevalence (**19.0%**) and mean egg count (**21.8 eggs/10 mL**).

Table 2: Prevalence and Mean Egg Count Among Participating Schools

School	No. Examined	No. Infected	Prevalence (%)	Mean Egg Count/10ml
Dallaje Model Primary School	100	19	19.0	21.8
Faru Primary School	98	29	29.5	33.4
Nasarawa Primary School	98	36	36.7	41.0
Rugar Jabe Primary School	96	28	29.1	32.9

4.1.4 Socio-Demographic Risk Factors

Parental occupational status was strongly associated with infection ($\chi^2 = 19.81$, $p < 0.0001$). Children of working parents had a prevalence of **57.5%**, compared with **25.3%** among children of non-working parents (OR = 3.99; 95% CI: 1.94–8.20).

By contrast, parental educational background showed no significant association with infection ($\chi^2 = 0.29$, $p = 0.5867$). Prevalence was **27.0%** among children of formally educated parents versus **29.8%** among those of non-formally educated parents (OR = 0.88; 95% CI: 0.59–1.32).

4.1.5 Water Contact Activities

Water-related behaviours were significantly associated with infection risk ($\chi^2 = 62.41$, $p < 0.0001$). Children engaged in **crossing water bodies** (72.0%) and **drinking untreated water** (88.9%) had the highest prevalence rates, while those involved in irrigation (13.8%) and fishing (47.1%) also showed elevated risks. Multivariable analysis confirmed swimming, crossing, and multiple water activities as independent predictors of infection (adjusted OR range: 2.4–6.9; all $p < 0.05$).

Table 3: Association of Socio-Demographic Factors with Infection Prevalence

Variable	No. Examined	No. Infected	No. Non-Infected	P-Value
Age Group (years)				0.2325
8–10	98	30	68	
11–12	243	63	180	
13–15	51	19	32	
Gender				<0.0001
Male	240	112	128	
Female	152	0	152	
Parental Occupational Status				<0.0001
Working	40	23	17	
Not-working	352	89	263	
Parental Educational Status				0.5867
Formal Education	189	51	136	
Non-Formal Education	205	61	144	
Water Contact Activity				<0.0001
Drinking	9	8	1	
Washing	27	14	13	
Swimming	77	21	56	
Fishing	17	8	9	
Irrigation	80	11	69	
Crossing	25	18	7	

Variable	No. Examined	No. Infected	No. Non-Infected	P-Value
At least two activities	157	32	125	

4.2 Discussion

4.2.1 Overall Prevalence and Gender Disparity

The overall prevalence of 28.6% confirms urinary schistosomiasis as a substantial public health burden around the Dallaje Reservoir. This figure falls within the moderate prevalence range reported across Nigeria (Amuta & Houmsou, 2014; Odeniran *et al.*, 2020) but is lower than rates exceeding 50% documented in hyperendemic zones (Dawaki *et al.*, 2016).

The total absence of infection among females is striking but consistent with studies in similar Hausa–Fulani communities (Ahmed *et al.*, 2021). Gender norms restricting female outdoor activities likely limit exposure, whereas boys’ involvement in swimming, fishing, and irrigation heightens risk (Senghor *et al.*, 2014). Comparable gender disparities have been noted in Bauchi State (Abubakar *et al.*, 2022) and in East African settings (Kabuyaya *et al.*, 2017). From a programmatic perspective, these findings support **gender-sensitive interventions**, prioritizing boys for preventive chemotherapy while ensuring community-wide education.

4.2.2 Age-Related Patterns

Although age was not statistically significant, infection peaked among early adolescents (13–15 years). This aligns with behavioural maturation, increased autonomy, and greater engagement in risky water activities (Houmsou *et al.*, 2016). Immuno-epidemiological evidence also suggests that cumulative exposure during late childhood precedes partial immunity in adulthood (Colley *et al.*, 2014). Thus, interventions should target children before adolescence to interrupt early transmission.

4.2.3 School-Specific Variation

Marked differences between schools highlight the micro-geographical heterogeneity of transmission. Schools closer to the reservoir (e.g., Nasarawa Primary) recorded higher prevalence and intensity. This mirrors patterns reported in Côte d’Ivoire (Coulibaly *et al.*, 2013) and KwaZulu-Natal, South Africa (Manyangadze *et al.*, 2016). Environmental determinants, including snail density and proximity to unsafe water, remain critical drivers (Steinmann *et al.*, 2006). Mapping high-risk schools could help tailor **school-based MDA** and water, sanitation, and hygiene (WASH) interventions more efficiently.

4.2.4 Socio-Demographic Determinants

Parental occupation emerged as a significant predictor: children of working parents were nearly four times more likely to be infected. This supports the hypothesis

that reduced supervision increases exposure opportunities. Similar associations were documented in Kano (Dawaki *et al.*, 2016). Conversely, parental education was not protective, consistent with our hypothesis and earlier reports from Nigeria and Senegal (Onasanya *et al.*, 2020; Senghor *et al.*, 2014). This suggests that **formal education alone does not translate into effective schistosomiasis prevention** without practical behavioural change programs.

4.2.5 Water-Contact Activities

Behavioural factors were the strongest predictors of infection. Activities such as swimming and crossing water bodies carried odds ratios above 5, underscoring their role in sustaining transmission. Similar findings have been reported across West Africa (Senghor *et al.*, 2014; Ahmed *et al.*, 2021) and in meta-analyses (Odeniran *et al.*, 2020). These results reinforce the need for **behavioural modification campaigns** and **provision of safe water alternatives**.

4.2.6 Implications for Control and Elimination

This study confirms that schistosomiasis transmission around the Dallaje Reservoir is sustained by a nexus of socio-cultural and behavioural factors. Current WHO guidelines recommend annual praziquantel treatment in areas where prevalence exceeds 10% (WHO, 2022). At 28.6%, the Dallaje area clearly meets this threshold. However, MDA alone is insufficient; snail control (Lo *et al.*, 2021), WASH interventions, and targeted health education must be integrated.

The findings align with the WHO 2030 NTD roadmap, which emphasises **elimination as a public health problem** through integrated, context-specific interventions (WHO, 2023). School-based programs, gender-sensitive health education, and environmental management of snail habitats should form the cornerstone of local strategies.

4.2.7 Limitations

This study has several limitations. First, its cross-sectional design precludes causal inference. Second, the absence of infection among females may reflect true zero prevalence or sampling bias; larger studies are needed for confirmation. Third, self-reported water-contact activities may be subject to recall bias. Nonetheless, the robust sample size, use of standard diagnostic procedures (Cheesbrough, 2005), and multivariable analysis enhance reliability.

5.0 CONCLUSION

Urinary schistosomiasis remains endemic in the Dallaje Reservoir communities, with nearly one-third of

schoolchildren infected. Transmission is driven by gender, parental occupation, and risky water-contact behaviours. Control efforts should prioritise boys, high-risk schools, and behavioural interventions, alongside mass drug administration and improved WASH facilities. By integrating these strategies with the WHO 2030 roadmap, schistosomiasis elimination in Katsina State is achievable.

6.0 RECOMMENDATIONS

This study demonstrates that urinary schistosomiasis in the Dallaje Reservoir communities is sustained by socio-demographic and behavioural factors, particularly male gender, parental occupational status, and water-contact activities. Based on these findings, the following interventions are recommended:

- i. **Targeted Health Interventions:**
 - a. Design gender-sensitive education programs with emphasis on boys, who are at highest risk due to water-related activities.
 - b. Implement school-based health promotion focusing on behavioural change and safe water practices.
- ii. **Water, Sanitation, and Hygiene (WASH):**
 - a. Provide reliable access to safe water sources (e.g., boreholes, protected wells).
 - b. Improve sanitation facilities to reduce open urination/defecation and prevent contamination of local water bodies.
- iii. **Chemotherapy and Case Management:**
 - a. Sustain annual praziquantel mass drug administration (MDA) for all school-aged children in line with WHO recommendations.
 - b. Extend treatment to out-of-school children and high-risk adult groups through community outreach.
- iv. **Integrated Vector Control and Surveillance:**
 - a. Incorporate snail control strategies where feasible, complemented by routine epidemiological and malacological surveillance.
 - b. Establish monitoring systems in schools to evaluate infection trends and intervention outcomes.
- v. **Policy and Research Priorities:**
 - a. Strengthen multi-sectoral collaboration between health, education, and water-resource agencies.
 - b. Conduct further research on socio-cultural determinants, climate variability, and their impact on transmission dynamics.

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CONFLICT OF INTEREST

The authors declare no competing interests. No financial, personal, or institutional relationships influenced the design, execution, or reporting of this study.

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