



Distribution of urinary schistosomiasis and associated risk factors among school-age children in Kwara State, Nigeria

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Abstract

Schistosomiasis remains a public health concern in developing countries. This study assessed the current status of urinary schistosomiasis among school-age children in Kwara State, Nigeria. Of the 1,341 school-age pupils investigated, 277 (20.7%) were infected, with 26.84% from Kwara South, 18.83% from Kwara Central, and 14.29% from Kwara North. The overall geometric mean intensity and mean population egg density varied significantly across the senatorial districts (9.37 ± 2.66 versus 14.95 ± 16.41 eggs per 10mL of urine). Males (22.3%) were more infected than females (19%), while children aged > 15 and ≤ 5 years had the highest prevalence and intensity, respectively (37.5%; 12.18 ± 2.74 eggs per 10mL of urine). A binary logistic regression analysis indicated that the source of drinking water, duration of community-stay, and non-awareness of infection were not significant predictors of *Schistosoma haematobium* infection. All forms of water contact activities were associated with increased and significant ($p < 0.01$) odds of predicting *S. haematobium* infection, the most important being fishing [Odd Ratio (OR): 114.951, $p < 0.001$]. Daily, weekly, and monthly water contact frequency was insignificant in predicting the odds of *S. haematobium* infection. However, no history of previous drug treatment was a significant risk factor (OR: 2.092; $p = 0.002$). Urinary schistosomiasis is very much present among school-age children in Kwara State. Strengthening schistosomiasis surveillance systems to identify communities with no or long history of preventive chemotherapy and ensuring even distribution of these resources is critical to morbidity reduction and disease control.

Keywords *Schistosoma haematobium* · Prevalence · Risk factor · Senatorial districts · Kwara State

Introduction

Schistosomiasis, also known as bilharziasis or “snail fever,” is a waterborne parasitic disease caused by several digenetic trematodes in the genus *Schistosoma*. The disease is of public health concern worldwide, particularly in sub-Saharan Africa, where it ranks second to malaria in terms of human impact (WHO 2023). *Schistosoma mansoni*, *S. intercalatum*, *S. japonicum*, and *S. mekongi* are the causative agents of intestinal schistosomiasis, while *S. haematobium* is the sole cause of urinary schistosomiasis (Abe et al. 2018).

More people are infected with *S. haematobium* than the other schistosome species combined. Urinary Schistosomiasis accounts for more than 90% of all schistosomiasis cases in Nigeria, suggesting that the Disability-Adjusted Life Years (DALYs) in Nigeria resulting from schistosomiasis are mainly from urinary schistosomiasis (Ezeh et al. 2019). The disease is widespread, with prevalence varying between 2 and 90%, of which most cases occur among school-age children and those with low socio-economic status (Oladejo et al. 2006, Ugbomoiko 2000). Infection is acquired during domestic, occupational, and recreational activities that expose humans to water infested with cercariae from snail which serve as intermediate host of the parasite. A high prevalence rate is seen in rural areas where surface water bodies are the sole source of water (Salawu et al. 2016). Proximity to water bodies, dam construction sites, and irrigation projects, as well as socio-demographic factors, have been implicated in the spread of schistosomiasis in endemic

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areas (Kabuyaya et al. 2017; Adenowo et al. 2015; Ugbo-moiko et al. 2010).

The primary intervention for control by the World Health Organization (WHO) is preventive chemotherapy through periodic Mass Drug Administration (MDA) for all at-risk groups viz.; pre-school and school-age children, individuals who make contact with infested surface water due to their occupation, and individuals living in endemic communities (WHO 2023). Over the years, Praziquantel (PZQ) has been the drug of choice due to its efficacy against all the species of schistosomes (Hastings 2016). Nigeria has benefited from control programs and several internationally funded projects. Nigeria's schistosomiasis control efforts were significantly boosted in 2016 when the Merck Group donated the largest single praziquantel to African nations for mass distribution and administration. Despite the significant increase in the PZQ treatment coverage index, parasite transmission is still unabated, as evidenced in many epidemiological foci (Ijaiya et al. 2020; Jiya et al. 2022; Akindele et al. 2020; Nwachukwu et al. 2018; Nduka et al. 2019).

Earlier studies on urinary schistosomiasis in Kwara State focused on the distribution, pattern, knowledge, and associated risk of infection among school-age children (Bello et al. 1992; Edungbola et al. 1988; Sunday et al. 2017; Babamale et al. 2018; Awosolu 2016; Bolaji et al. 2015). Recently, a community-based survey cutting across all age groups was carried out to rapidly assess *S. haematobium* infection in some parts of the State (Sunday et al. 2023). Although sole reliance on preventive chemotherapy is insufficient to yield long-term control success, a reduction in morbidity is expected, considering the recent efforts geared toward disease control. Therefore, this research aimed to provide information on the current status of urinary schistosomiasis in selected communities in Kwara State.

Materials and methods

Study area

This study was carried out in Kwara State, which is situated in the North-Central region of Nigeria. Kwara State consists of three (3) senatorial districts (Kwara North, Kwara Central, and Kwara South) [Fig. 1], with a total of sixteen (16) Local Government Areas (LGAs). The State is between latitude 9°38'54.6642" and longitude 5°7'41.6496", with a land mass of 34,244 square kilometres. According to the National Bureau of Statistics (NBS 2016), the estimated human population is around 3.2 million. The State enjoys a tropical climate with distinct dry (November–March) and rainy (April–October) seasons, with maximum temperatures ranging between 25.7 °C and 33.7 °C. Nupe and Yoruba are

the significant ethnic groups in the study locations. Infrastructures such as health care facilities, electricity, and pipe-borne water are inadequate in the study areas. Also, most of the areas have some form of dependence on surface waters for their domestic and agricultural activities.

Ethical consideration

Ethical approval was obtained from the Kwara State Ministry of Health Research and Ethical Committee (Ref. No.: ERC/MOH/2023/01/085). Also, approval was sought from community and school heads prior to sample collection. Finally, informed consent was obtained from the parents/caregivers of each child through the Parent Teacher Association (PTA) before enrolment in the study.

Study population

After preliminary visits to randomly selected schools, children between the ages of 4–20 years were recruited from the study areas. Children with duly signed consent forms by parents/guardians who had stayed a minimum of 6 months prior to the commencement of the study were enlisted to participate in the study. Exclusion criteria are those whose parents declined consent, menstruating females and those who had not spent up to 6 months in the community.

Sample collection

Samples were collected between June, 2023 – September, 2023. Each volunteer in the selected local government areas was given pre-labeled, clean plastic screw-cap bottles to be filled with urine between 10 am and 1 pm, which corresponds to the peak of egg output in urine (Cheesbrough 2009). At the point of collection of urine samples, structured questionnaires were administered to obtain the bio-data, socio-demographic, and other risk-related information associated with schistosomiasis. Microhaematuria and proteinuria were immediately assessed using commercial reagent strips (Medi-test Combur-9; Analytic on Biotechnologies, Lichtenfels, Germany). Afterward, all samples were preserved and transported to the Parasitology Laboratory, Zoology Department, University of Ilorin, for examination.

Sample processing

The filtration method was used to detect *S. haematobium* eggs in urine samples. Briefly, 10 mL of urine sample was drawn into a syringe and passed through a qualitative paper filter with pore size of 8 µm to recover eggs. The filter was stained with 10% Lugol's iodine and examined under the 10x objective of a light microscope. *S. haematobium* eggs

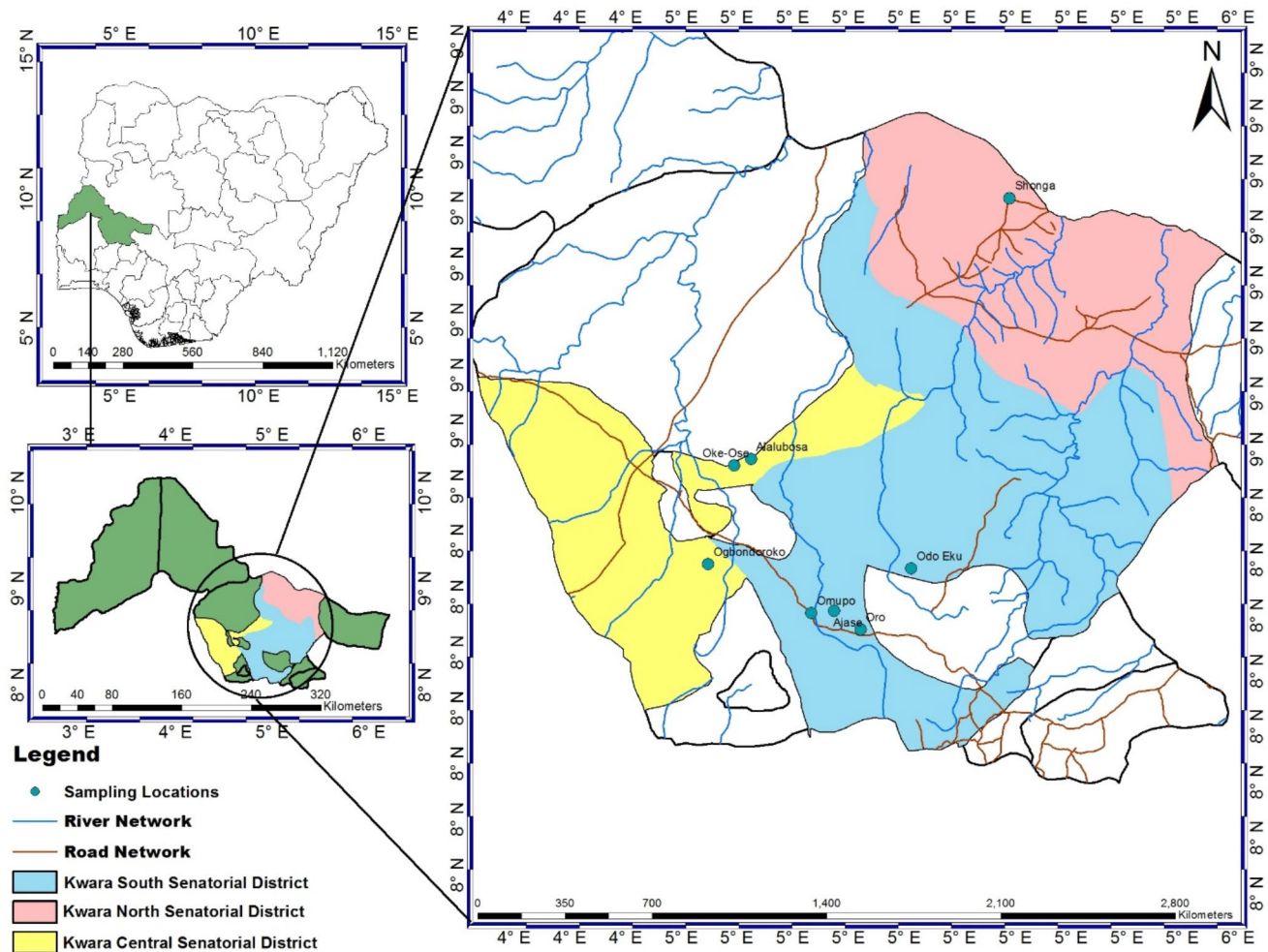


Fig. 1 Map of Kwara State with senatorial districts

stained orange and were counted. The intensity of infection was graded as light (1–49 eggs/10 mL), moderate (50–499 eggs/10 mL), and heavy (> 500 eggs/10 mL) according to World Health Organization guidelines (WHO 1991).

Data analysis

All data was entered and analyzed using Statistical Package for Social Sciences (SPSS) version 24. The difference in proportions was tested using Fisher's exact and Chi-square tests for the age group and sex variables, respectively. The difference in means was tested using one-way ANOVA and Student t-test for the age group and sex variables, respectively. A binary logistic regression analysis was used to assess the risk of *S. haematobium* infection, and a chart was created using Microsoft Excel.

Results

Out of the 1341 pupils recruited into the study, 277 were infected with *S. haematobium*, culminating in an overall prevalence of 20.7% (Fig. 2). The prevalence of infection differed significantly with location viz., 26.84% (Kwara South), 18.83% (Kwara Central), and 14.29% (Kwara North), $p < 0.0001$. The overall geometric mean intensity of 9.37 eggs/10 mL urine and mean population egg density of 14.95 eggs/10 mL urine varied significantly with location (Table 1). Participants from Kwara South had the highest mean population egg density (17.85 ± 18.47) compared to other locations ($p = 0.015$).

Overall, males (22.3%) had a non-significantly higher prevalence of *S. haematobium* infection than females (19%). In Kwara South, a significantly higher number of males were infected than females ($p = 0.017$). Similarly, a significantly higher egg intensity was observed in males (10.50 ± 2.50) than their female counterparts (8.22 ± 2.81) [Table 2]. The prevalence of *S. haematobium* infection significantly varied

Fig. 2 Overall prevalence of infection with respect to senatorial districts

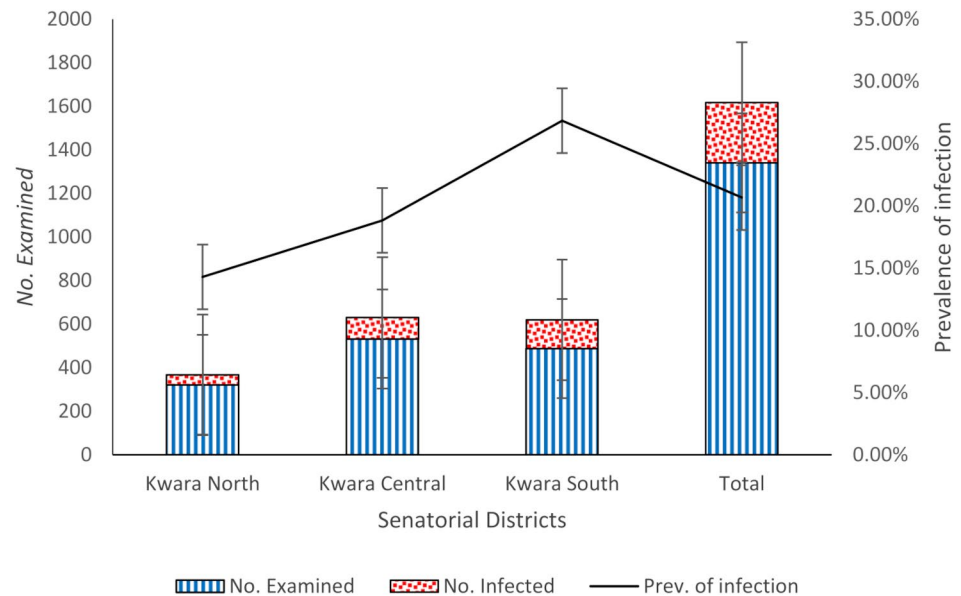


Table 1 Intensity of urinary schistosomiasis among children in Kwara State

Senatorial district	No. examined	Geometric mean intensity		Mean population egg density	
		X ± SD	95% CI	X ± SD	95% CI
Kwara Central	531	7.54 ± 2.54	6.27–9.05	11.63 ± 12.67	9.33–14.27
Kwara North	322	8.43 ± 2.72	6.47–11.58	13.91 ± 16.24	8.66–22.88
Kwara South	488	11.47 ± 2.64	9.71–13.58	17.85 ± 18.47	14.88–21.16
Total	1341	9.37 ± 2.66	8.33–10.52	14.95 ± 16.41	13.09–17.01
p. value		0.004**		0.015**	

**Significant $p < 0.05$

among age groups (Table 3). Overall, children over 15 years of age had a higher infection prevalence (37.5%) than other age groups ($p = 0.023$). A similar pattern was observed in Kwara North and Kwara South (37.5%, $p = 0.015$ vs. 52.9%, $p = 0.032$). Also, the highest intensity of infection was observed in Kwara South in children of ≤ 5 (16.06 ± 2.55 , $p = 0.795$).

A binary logistic regression analysis of the risk factors for *S. haematobium* infection showed that source of water, duration of water contact, duration of community-stay, and awareness of infection were insignificant in predicting the odds of *S. haematobium* infection (Table 4). However, no history of previous drug treatment significantly predicted the risk of urinary schistosomiasis ($OR = 2.092$, $p = 0.002$). Similarly, all forms of water contact activities were associated with increased and significant ($p < 0.01$) odds of predicting *S. haematobium* infection, the most important being fishing ($OR = 114.951$, $p < 0.001$).

Discussion

This study evaluated the prevalence pattern, intensity, and associated risk of *Schistosoma haematobium* infection among school children in Kwara State, Nigeria. The overall prevalence of infection recorded (20.7%) was relatively lower than earlier reports from this study area (Babamale et al. 2018; Bolaji et al. 2015), Southwest region (Akindele et al. 2020), and other endemic African regions (Bong et al. 2022; Elsiddig et al. 2019; Sa´nchez-Marques et al. 2023). However, lower prevalence rates have been observed in the Southeastern zone (Nwachukwu et al. 2018), the Southwestern zone (Sunday et al. 2017; Straily et al. 2024), and neighbouring African countries (Joof et al. 2021; Tamomh et al. 2018).

The traditional urine filtration method adopted in this study, which has been the gold standard in the assessment of prevalence and intensity of infection showed a comparable result as that obtained by Straily et al. (2024), even though measuring antibody responses to soluble egg antigen (SEA) produces more reliable estimate for national reporting and surveillance.

Table 2 Prevalence of urinary schistosomiasis stratified with gender in Kwara State

Senatorial district	Gender	Prevalence				Geometric mean intensity	
		No. examined	No. (%) positive	$X \pm SD$	95% CI	$X \pm SD$	95% CI
Kwara Central	M	263	52(19.8)	13.42 ± 14.31	14.8–24.7	9.12 ± 2.40	7.15–11.54
	F	268	48(17.9)	9.69 ± 10.40	13.4–22.8	6.14 ± 2.61	4.71–8
p. value			0.583			0.029**	
Kwara North	M	148	17(11.5)	13.59 ± 14.73	6.8–16.9	8.51 ± 2.78	5.37–14.18
	F	174	29(16.7)	14.1 ± 17.32	10.9–22.4	8.38 ± 2.73	5.88–12.08
p. value			0.186			0.960	
Kwara South	M	247	78(31.6)	17.46 ± 15.46	25.9–37.7	12.09 ± 2.47	10.08–14.76
	F	241	53(22)	18.42 ± 22.33	16.6–27	10.62 ± 2.89	7.97–14.01
p. value			0.017**			0.436	
Total	M	658	147(22.3)	15.59 ± 15.01	19–25.5	10.50 ± 2.50	9.03–12.15
	F	683	130(19)	14.23 ± 17.89	16–22.1	8.22 ± 2.81	6.88–9.92
p. value			0.135			0.051	

** Significant $p < 0.05$

The low prevalence observed in this study could be attributed to drug intervention, although not regular, enjoyed by some of the studied communities, as observed from the school's treatment records. The uneven distribution of this intervention could have influenced the higher prevalence rate and mean egg intensity observed in Kwara South, as some school heads with almost a decade of overseeing the affairs of the school self-reported and claimed not to have benefitted from such school-based interventions in times past. Conversely, Kwara North, previously documented as

highly endemic for urinary schistosomiasis (Sunday et al. 2017; Babamale et al. 2018; Nyamngee et al. 2018), showed the least prevalence compared to other senatorial districts. It was observed that MDA among school-age children was intensified in this region considering their past antecedent.

The overall geometric mean intensity of infection in this study is comparable to observations from southern Nigeria (Opara et al. 2021). The gender bias in the pattern of infection was insignificant. Males were more infected than females ($p = 0.135$), a finding that is comparable with

Table 3 Prevalence of urinary schistosomiasis stratified with age-group in Kwara State

Senatorial district	Age-group (yrs.)	Prevalence			Geometric mean intensity	
		No. examined	No. (%) positive	95% CI	$X \pm SD$	95% CI
Kwara Central	≤ 5	24	8(33.3)	15.6–55.3	9.94 ± 3.02	3.94–25.04
	6–10	215	42(19.5)	14.5–25.5	7.80 ± 2.37	5.96–10.20
	11–15	285	50(17.5)	13.3–22.5	7.01 ± 2.64	5.32–9.23
	> 15	7	0(0)	0	0	0
p. value			0.180		0.592	
Kwara North	≤ 5	12	3(25)	5.5–57.2	10.99 ± 3.14	1.56–188.4
	6–10	160	16(10)	5.8–15.7	7.33 ± 2.90	4.15–12.94
	11–15	134	21(15.7)	10–23	8.50 ± 2.78	5.33–13.53
	> 15	16	6(37.5)	15.2–64.6	10.42 ± 2.32	4.30–25.22
p. value			0.015**		0.860	
Kwara South	≤ 5	36	7(19.4)	8.2–36	16.06 ± 2.55	6.75–38.18
	6–10	216	50(23.1)	17.7–29.4	11.68 ± 2.76	8.74–15.59
	11–15	219	65(29.7)	23.7–36.2	11.05 ± 2.51	8.80–13.88
	> 15	17	9(52.9)	27.8–77	10.42 ± 3.25	4.21–25.77
p. value			0.032**		0.795	
Total	≤ 5	72	18(25)	15.5–36.6	12.18 ± 2.74	7.37–20.12
	6–10	591	108(18.3)	15.2–21.6	9.31 ± 2.67	7.73–11.23
	11–15	638	136(21.3)	18.2–24.7	8.98 ± 2.64	7.61–10.58
	> 15	40	15(37.5)	22.7–54.2	10.2 ± 2.78	5.92–18.37
p. value			0.023**		0.631	

** Significant $p < 0.05$

Table 4 Binary logistic regression for the determination of the predictors of *Schistosoma haematobium* among children in Kwara State

Variable	B coefficient	Odd ratio (OR)	95% CI for Odds ratio	p value
Source of water				
Well	-0.010	0.990	0.649–1.511	0.963
Stream/river	-0.332	0.717	0.462–1.114	0.139
Pipe borne water			1	
Water contact activities				
Bathing	3.728	41.585	9.290–186.152	< 0.001**
Washing	3.924	50.587	11.252–227.430	< 0.001**
Fetching	4.131	62.235	13.277–291.723	< 0.001**
Fishing	4.745	114.951	14.959–883.303	< 0.001**
Farming	3.443	31.274	5.612–174.272	< 0.001**
No contact			1	
Frequency of water contact				
Daily	-0.06	0.942	0.011–0.870	0.956
Weekly	-0.244	0.783	0.091–6.735	0.824
Monthly	-0.353	0.703	0.081–6.127	0.749
Rarely	-2.311	0.099	0.011–0.870	0.037**
None			1	
Duration of water contact				
Long > 5 min	0.275	1.317	0.199–8.718	0.776
Short < 5 min	0.183	1.2	0.177–8.163	0.852
None			1	
Duration of community stay				
6–12 months	0.245	1.278	0.507–3.217	0.603
13–24 months	0.662	1.939	0.958–3.922	0.065
			1	
Last drug intervention				
Never	0.738	2.092	1.320–3.315	0.002**
3 months	0.335	1.398	0.949–2.060	0.090
> 6 months			1	
Awareness of infection				
No	-0.008	0.992	0.677–1.454	0.968
Yes			1	

** Significant $p < 0.05$

observations of other authors (Akinboye et al. 2011; Opara et al. 2021; Saotoing et al. 2016; Chikwendu et al. 2019; Fola-han et al. 2021). This, however, is a marked deviation from other reports (Ntonifor et al. 2015; Oladeinde et al. 2018; Lawiye et al. 2020), where females were more infected than males. The insignificant gender-related infection pattern in this study indicates that both sexes were equally exposed to infection.

The overall pattern of infection stratified with age indicated that children > 15 years of age were predominantly infected. Observations from this study showed that children in this age group mainly visited water bodies to wash or fetch, predisposing them to the infection. This corroborates the report that older age groups are more involved in water-related activities than younger age groups (Bong et al. 2022). Another pertinent observation from this study was that children aged ≤ 5 had the highest mean egg intensity. Awosolu (2016) put forward a similar finding among children aged ≤ 4

years. However, Babamale et al. (2018) documented contrasting results. Children in the age group ≤ 5 are known to be under the protective care of their parents, and a high egg intensity is highly suggestive of long-term exposure. A plausible reason for this marked disparity could be that some participants in this age group might have been excluded during MDA. Also, as highlighted by Moyo et al. (2016), there is growing evidence of a high occurrence and burden of urinary schistosomiasis in preschool-age children. This calls for great concern since no approved pediatric PZQ formulations cater to children below four years of age.

Amidst the significant morbidity indicators of urinary schistosomiasis such as haematuria (presence of blood in the urine), dysuria (pain during urination or difficulty urinating), and proteinuria (protein in urine), haematuria is the most common sign of infection. Findings from this study revealed that only 1.3% of the population had visible haematuria. However, this is lower than reports from other

study areas (Ugbomoiko et al. 2009; Sunday et al. 2023; Akindele et al. 2020).

The present study showed that the source of drinking water, the frequency of water contact, the duration of water contact, the duration of stay in the community, and awareness of infection were not associated with the prevalence of urinary schistosomiasis. Several authors have shown that these factors are, in fact, very important in predicting the risk of disease acquisition (Bong et al. 2022; Adamu et al. 2019; Gamde et al. 2023; Sumbele et al. 2021). For instance, children whose source of drinking water is the river usually exhibit a higher prevalence of urinary schistosomiasis because the lack of pipe-borne water brings them in contact with cercariae-infested water bodies. Similarly, long residency in an endemic area is a significant risk factor for the continuity of *S. haematobium* transmission (Mushi et al. 2022). Other prevailing factors linked to the prevalence of urinary schistosomiasis by other authors include poor hygiene and proximity to water bodies (Ugbomoiko et al. 2010), father's occupation (Awosolu 2016), unemployment, and lack of knowledge of the infection (Babamale et al. 2018). This study also revealed that all water contact activities were significantly associated with the prevalence of infection, with fishing constituting the highest risk ($OR = 114.951$, $p < 0.001$). This buttresses the need for a safe water supply and more awareness programs that will change human behaviour. However, completely dissociating visits to water bodies will be a herculean task as most of the inhabitants of these study areas are dependent on surface waters for farming, an activity in which children actively participate. Another significant predictor of urinary schistosomiasis in this study was the last drug intervention. Children who have never received any drug intervention in the past were twice as likely to be at risk of being infected.

Conclusion

Despite the recent initiatives to curb urinary schistosomiasis, the disease persists in Kwara State. Findings from this study call for the strengthening of schistosomiasis surveillance systems, provision of safe water supply, improved health education, and even distribution and inclusion of communities with no or long history of preventive chemotherapeutic intervention, all of which play a crucial role in morbidity reduction and disease control. Efforts must be intensified in providing pediatric PZQ formulation to cater to the growing burden of urinary schistosomiasis in pre-school age groups. Lastly, a global elimination plan may only be achievable with an integrative control approach.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s12639-024-01745-4>.

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Declarations

Conflict of interest The authors declare that there is no conflict of interest.

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