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Prevalence of *Schistosoma haematobium* infection and Nutritional Status of Primary School Children in Kubau and Kaura LGA of Kaduna State, Nigeria

Charity Nyalian Shemang*, Helen Ileigo Inabo, Muhammad Sani Aliyu

Department of Microbiology, Faculty of Life Sciences, Ahmadu Bello University, Zaria, Kaduna State, Nigeria

Author for Correspondence*: shemancharity98@gmail.com/+234-805-491-5078

<https://dx.doi.org/10.4314/sokjmls.v10i3.28>**Abstract**

The aim of this study was to determine the prevalence of *Schistosoma haematobium* infection and the nutritional status of primary school children in parts of Kaduna State, Nigeria. Two hundred and eighty (280) urine samples were collected from school children in twenty-eight (28) randomly selected schools from Kubau LGA, and one hundred and twenty (120) urine samples were collected from school children in ten (10) randomly selected schools from Kaura LGA, Kaduna state, Nigeria. One single sample was collected from each child. Urine samples were examined by microscopy and the centrifugation concentration technique. A total of 31 children were infected with *Schistosoma haematobium*, with a prevalence of 7.8%. All positive cases were recorded from Kubau LGA with a prevalence of 11.1%. Female children had a prevalence of 5.6% while males had 9.4% (females = 177, males 223, $p = 0.162$). There was a statistically significant association in infection and intensity among age groups ($p = 0.002$) with the 14-16 years age group having the highest prevalence of 22.1%, while the 8-10- and 11-13-years age groups had heavy infections (50 ova/10ml urine). The 5-7 years age group recorded zero percent prevalence. Haematuria was associated with infection (OR = 6.73, $p = 0.000$). Inadequate sanitary facilities in schools was a risk factor for infection (OR = 13.2, $p = 0.000$). There was no significant association between nutritional status and urinary schistosomiasis in the population ($p = 0.193$). Synergy between rural schools and health care facilities through education and screening of rural at-risk groups, and availability of drugs could build up steps towards eradication.

Keywords: Prevalence, haematuria, *Schistosoma haematobium*, school children, LGA**Introduction**

1. Schistosomiasis is an acute and chronic parasitic disease caused by blood flukes of the genus *Schistosoma* (WHO (2022)). In Africa, *Schistosoma mansoni* and *Schistosoma haematobium* are the most prevalent throughout the continent (Etefia, 2019). Globally, *Schistosoma haematobium* has been reported as the most prevalent species of schistosomes accounting for over 112 million vulnerable populations, 80 million cases and over 150 000 deaths annually (Mazigo *et al.*, 2012). The disease is spread by snails species of the genus *Bulinus* which expels its infective larva cercariae into slow moving fresh water sources such as streams and pond, which become sources of infection to humans that come in contact with these sites (Karunamoorthi *et al.*, 2018; Lalaye *et al.*, 2019). Water contact activities such as playing, bathing, swimming, and irrigation farming have been found to predispose people to infections, and children are reported to be at higher risk of being infected (FMOH, 2015; WHO, 2022). As school age children are more likely to contact these freshwater bodies, they have an increased risk of getting infected with schistosomiasis; hence most studies target this age group (Rollinson *et al.*, 2013; Mewabo *et al.*, 2017). The World Health Organization (WHO) recommended methods for mapping and field diagnosis of

urinary schistosomiasis are the urine filtration technique and microscopy for detecting eggs of the parasite in urine (Utzinger *et al.*, 2015). Urine dipstick is also often used alongside the filtration technique to detect microhaematuria, together with self-reported haematuria using questionnaires (Weerakoon *et al.*, 2015).

2. Lack of proper nutrition resulting from unbalanced intake of food as well as infectious diseases have contributed to malnutrition among children in developing countries including Nigeria, as well as in the developed countries (Bhattacharya *et al.*, 2019). According to the World Health Organisation (WHO, 2020) overweight and obesity which were once considered a problem for high-income countries is now on the rise even in low-income and middle-income countries particularly in urban areas. This was shown to be the result of consumption of nutrient dense foods high in sugar and fat as well as decrease physical activity and sedentary forms of work. The lack of access to proper nutritious foods can worsen the impact of infectious disease which most developing countries are battling with and increase the risk of mortality among infants and children (WHO, 1995). It was shown in a study in India that not only do children have risk of infection, but also infection related-morbidity. This was observed in children with low Body Mass Index (BMI) for age than those with normal weight (Dobner and Kaser, 2018). According to Mazigo *et al.* (2012), shown in a study in Tanzania, light to severe infections in children with *Schistosoma* species commonly found in Africa is associated with stunted growth as well as undernutrition in the affected children. Children heavily infected with *Schistosoma species* had lower height and weight compared to those who were not infected. In Africa, the number of overweight children who are under 5 years have increased by nearly 24%. The prevalence of obesity in children and adolescents 5-19 years generally, have also

increased from 4% to just over 18% in 40 years. The risk for noncommunicable diseases such as colon cancer and heart disease increases with an increase in Body mass index in both children and adults (WHO, 2022).

The purpose of this research was to determine the prevalence of *Schistosoma haematobium* infection and its relationship with nutritional status among primary school children in some selected primary schools in Kubau and Kaura LGAs of Kaduna State, Nigeria.

Materials and Methods

Study Area and Population

The study was carried out in Kubau and Kaura Local Government Areas (LGAs) of Kaduna state, Nigeria (Figure 1). Kubau LGA Latitude 10° 30' 00" N - 11° 15' 00" N and Longitude 8° 00' 00" E - 8° 30' 00" E. It has a land mass of 2,291.0 sq. km and an estimated population of 280 704 from the 2006 Census figures. Kaura LGA has the following coordinates: Latitude 9° 30' 00"N - 9° 15' 00" N and Longitude 8° 15' 00" E - 8° 45' 00"E. It has a land mass of 623.0 sq. km and an estimated population of 174,626, census figures of the National Population Commission (NPC, 2006).

Both Local Government Areas comprise of people who are predominantly farmers. They engage in different agricultural activities such as crop production (food and cash crops), livestock production, and fishery. According to the Kaduna State Bureau of Statistics (Kaduna State Bureau of Statistics, 2018), Kubau LGA is involved in 100% crop production and Kaura LGA 91%. This is possible because of available fertile soils and abundance of water during the raining season, and rivers distributed in different locations in the areas with some being seasonal. Dams have also been constructed in these LGAs for various purposes such as water projects and irrigation purposes. Perennial farming is hence practiced (Mamman, 2012; Idu and Muhammad, 2015). The study population was apparently healthy children from randomly selected primary schools in Kubau and Kaura LGAs Kaduna state, Nigeria.



Figure 1: Map of Nigeria showing Kaduna State and the Study Areas Kubau and Kaura LGAs (Source: Adapted and Modified from Administrative Map of Kaduna State).

Ethical clearance

Ethical approval for the Research was obtained from Health Research Ethics committee of Kaduna State Ministry of Health (MOH/ADM/744/VOL.1/528. NHREC/ 17/03/2018) and the permit for the study from Kaduna State Universal Basic Education Board, KSUBEB (KD/SUBEB/573/VOL. III) and Local Government Education Authorities.

Study Design

This was a cross-sectional study that was carried out in parts of Kaduna State, Nigeria. A random sampling method was used to select schools that were included in the study. Ten (10) children each were selected from 28 schools in Kubau, and twelve (12) children from 10 schools in Kaura LGA. The selection included male and female children from primary 1 to 6 aged 5-16years.

Inclusion criteria

Primary school children within the age group of

5-16years who gave their consent were enrolled in the study.

Exclusion criteria

Out-of-school children were excluded from the study.

Determination of sample size

Sample size was determined by the method of Sarmukadden and Gerard (2006) using a population proportion of 50% at 95% confidence, using the formula below:

$$n = z^2 pq/L^2$$

Where n= sample size

Z= standard normal distribution

p= 50% (0.5) estimate proportion of population

q= 1- 0.5 = 0.5

L= allowable error = 5% level of precision

$$= 1.96^2 \times 0.5 \times 0.5 / 0.05^2$$

$$n = 384.16$$

A total of 400 urine samples were collected from apparently healthy school children.

Administration of a structured questionnaire

Before the commencement of the collection of samples, structured questionnaires were used to obtain information on socio-demographic as well as associated risk factors of infection with *Schistosoma haematobium*.

Collection of samples

Clean, dry, screw-capped, water-proof, and labelled plastic sampling bottles were given to the children with instructions on how to collect the urine samples. The younger children were assisted by the teachers in the collection. Approximately 20ml of urine was collected into the sampling bottles provided, which were properly labelled for each child. These bottles were placed in polythene bags, transported in a cold box to the laboratory

Microscopic examination of urine samples

1. The urine sample was properly mixed and 10ml was transferred into plastic conical centrifuge tubes and centrifuged at 4000 revolutions for 5minutes. The supernatant was discarded while the sediment was transferred unto a clean, grease-free, glass slide and covered with a cover glass carefully to avoid air bubbles. The entire slide was examined under the microscope using the 10x and 40x objectives of the microscope for eggs (ova) of *Schistosoma haematobium* (Cheesbrough, 2006). The intensity of infection was reported as number of eggs per 10ml of urine, while the samples without eggs were reported as negative.

Determination of Nutritional Status of Enrolled Children

Body Mass Index (BMI) of the children was determined by the measurement of height and weight. The Weight (in kilograms) was measured to the nearest kg with a simple portable weighing scale placed on a flat floor surface. Each child was measured without shoes and outer clothing, like a sweater, removed, with only their uniform. The height (cm), in standing position (Inocencio da Luz *et al.*, 2017), by using a calibrated 100cm ruler fixed to the wall. Each child was made to stand erect against the wall with the back of heels together on the wall while facing straight forward. The measuring ruler was placed

vertically against the wall where the child stood, and with the aid of another smaller ruler placed at the top of the head to the measuring instrument, the height was read. The nutritional status of the children was thus determined by calculating the BMI (WHO, 2022), where $BMI = \text{Weight (kg)}/\text{Height}^2 (\text{m}^2)$ - (Bhattacharya *et al.*, 2019)

The calculated values were compared with the WHO (2007) children and adolescent growth percentile values and were categorized as underweight, healthy weight, and overweight.

Statistical Analysis

Data collected from the pupils, together with laboratory results, were subjected to statistical analysis on SPSS version 23 at 95% confidence interval (CI). Prevalence and intensities in the population were calculated as percentages. Odds ratios were determined using the Fisher test. Nutritional status was determined by BMI-for-age of the school children and compared with percentile cut offs by WHO (2007).

Results

Table 1 shows a total prevalence of 11.1% for urinary schistosomiasis in 11 schools in Kubau LGA and zero percent prevalence of urinary schistosomiasis found in the population of children in Kaura LGA schools. There was a statistically significant difference in prevalence in the two LGAs ($\chi^2 = 14.402$, $p = 0.000$). There was an overall prevalence of 7.8% of urinary schistosomiasis in the schools studied.

The percentage intensity of infection according to the LGAs is shown in Table 4.2. Kaura LGA had zero percent intensity of infection while there were 2.5% heavy infections and 8.6% light infections in Kubau LGA. The total percentage heavy infections were 1.8%, and 6.0% light infections in Kubau LGA. There were more light infections recorded among the infected children. There was a statistically significant relation in the intensity of infection in the LGAs studied. Plate 1 shows ova of *Schistosoma haematobium* at 100 and 400 magnifications of a light compound microscope

Table 1: Occurrence of urinary schistosomiasis in study Local Government Areas

LGA	Number examined	Number Positive (%)	OR	df	Chi-square (p-value)
Kaura	120	0 (0.0)	1.124	1	14.402 (0.000)
Kubau	280	31(11.1)			
Total	400	31 (7.8)			

Table 2: Intensity of *Schistosoma haematobium* Infection in the study Local Government Areas (LGAs)

LGA	Intensity of infection (%)		df	Chi square	p-value)
	Heavy	Light			
Kaura	0.0	0.0	2	14.402	0.001
Kubau	2.58.6				
Total	7 (1.8)	24 (6.0)			

Light infections (≤ 50 ova/10ml urine) Heavy infections (> 50 ova/10ml urine)

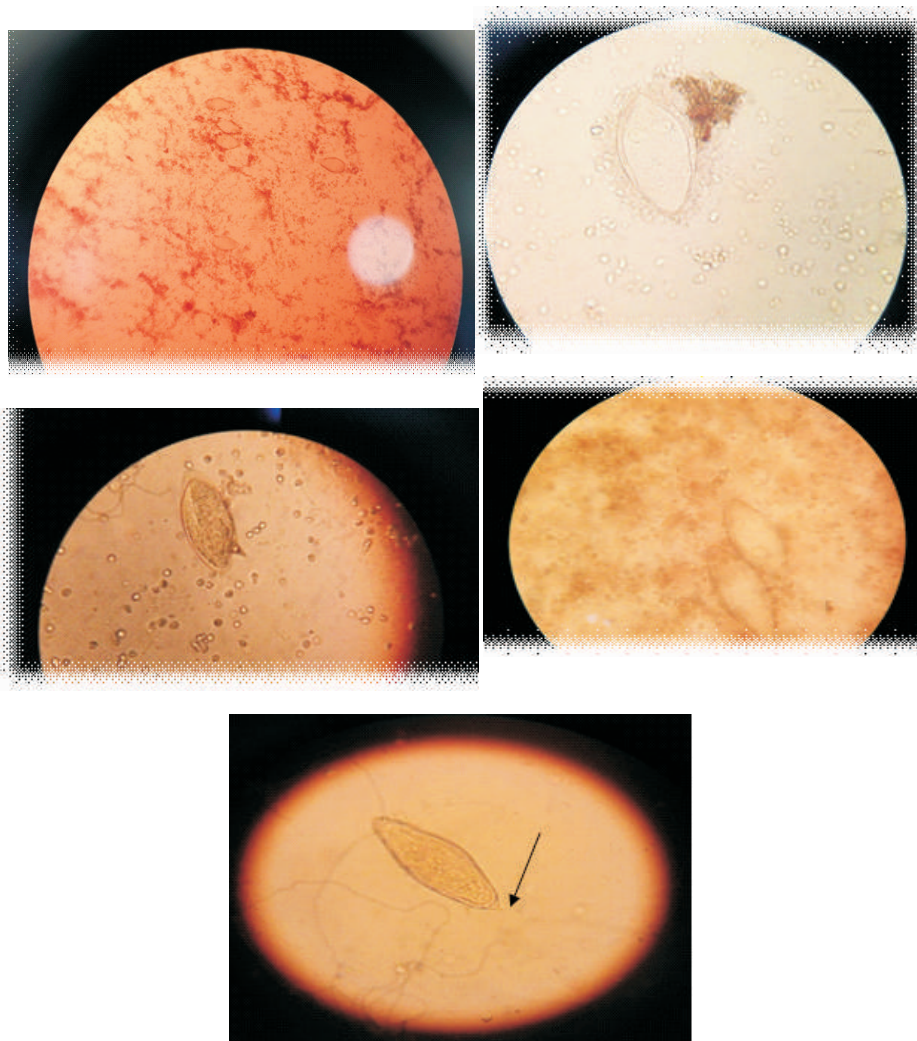


Plate I: Eggs of *S. haematobium* from urine sediments with a characteristic spine at 10x and 40x objective of light compound microscope.

Table 3 shows the prevalence of *Schistosoma haematobium* infection in relation to gender and age groups in the population. Of the total of 31 infected children, 10 (5.6%) were female children, and 21(9.4%) male children. There was no statistically significant difference in the infection rate based on gender ($\chi^2 = 1.959, p = 0.162$). There was however a statistically significant difference ($\chi^2 = 15.054, p = 0.002$) among the age groups in the study population, with the highest prevalence occurring among the 14-16 years group. There was no infection recorded in the age group 5-7 years. A few eggs of *Schistosoma mansoni* were ectopically present in the urine of 3 children, 2 males and I female (plate I).

Table 4 shows the intensity of infection in the population based on age groups. The highest level of intensity occurred among the age group 11-13 years who had 3.4% heavy infections and 7.8% light infections followed by the 8-10 age group, who had 1.7% and 6.4% heavy and light infections, respectively. The 14-16 years group had only light infections and the age group 5-7 years had no infection. There was a statistically significant relationship in the infection intensity among the age groups ($p = 0.004$). There was generally an occurrence of more light infections (50 eggs/10ml urine) than heavy (egg count < 50 eggs/10ml urine) among age groups infected.

Table 3: Gender and Age-related Prevalence of *Schistosoma haematobium* infection among children in parts of Kaduna State, Nigeria

Factor	Number Examined	Number (%) Positive	df	χ^2	(p-value)	OR
Gender						
Female	117	10 (5.6)	1	1.959	0.162	1.736
Male	223	21(9.4)				
Age (years)						
5-7	93	0 (0.0)	3	15.054	0.002	
8-10	173	14		8.1		
11-13	116	13		11		
14-16	18	4		22.1		

Chi-square, df= degree of freedom, CI = confidence interval

Table 4: The Intensity of infection in the Population based on age groups

Age Groups	Heavy Infections Number (%)	Light Infection Number (%)	df	chi square	(p-value)	95% CI
5-7	0(0.0)	0(0.0)	6	19.131	(0.004)	0.000-
8-10	3 (1.7)	11 (6.4)				0.007
11-13	4 (3.4)	9 (7.8)				
14-16	0 (0.0)	4 (22.2)				
Total	7 (1.8)	24 (6.0)				

Table 5 Table 5 shows the status of urinary schistosomiasis in association with children’s responses to toilet availability at home and at school, and also, the prevalence of urinary schistosomiasis in relation to proximity to a fresh water source to home. Children who responded to having no toilet facility at school recorded more infections with a prevalence of 13% compared to 1.1% for those who had toilet facility at school. There was a strong significant association between infection status and not having a toilet at school ($\chi^2 = 19.70, p = 0.000$). Those who had toilets at home had a prevalence of 7.9% compared to 7.5% for those children who said they had no toilets at home. There was no statistical difference between toilet availability at home and not having to the status of infection ($\chi^2 = 0.024, p = 0.878$). Those children whose houses were not close to a stream had 7.3% prevalence of urinary schistosomiasis compared to 9.6% prevalence among children whose houses were close to the stream. There was no statistically significant difference in infection status among school children whose houses were close to fresh water sources and those who were not ($\chi^2 = 0.52, p = 0.47$).

Table 6 shows the prevalence of urinary schistosomiasis with regards to contact with fresh water for recreational and domestic activities and contact (wading) enroute school. The children who do not engage in washing at the stream had a prevalence of 8.8% compared to those who washed at the stream with a prevalence of 6.6%. There was no statistical relationship among those who engaging in washing and those who do not ($\chi^2 = 0.671, p = 0.413$). Those children who did not take their bath or swim in fresh water had a prevalence of 6.5% compared to 8.8% among those children who did swim and took their baths in fresh water. There was no statistically significant difference among those children who do not take their bath and swim at fresh water and those who do ($\chi^2 = 0.719, p = 0.396$). Those children who do not wade through a stream on their way to school had a prevalence of 8.2%, compared to 5.2% who wade through a stream on their way to school. There was no significant difference, however among the children who waded through a stream on their way to school and those who do not ($\chi^2 = 0.35, p = 0.55$).

Table 5: Prevalence of *S. haematobium* and toilet availability and proximity to fresh water source close to home

Variable	Number Examined	Positive N (%)	OR	95% CI	df	Chi-square (p-value)
Toilet facility at school						
No	222	29 (13.1)				
Yes	178	2 (1.1)	0.076	0.018-0.322	1	19.698 (0.000)
Toilet facility at home						
No	121	9 (7.4)				
Yes	279	22 (7.9)	1.065	0.475-2.387	1	0.024 (0.878)
Proximity of house						
To stream						
No	317	23 (7.3)	1.363	0.587-3.169	1	0.522 (0.470)
Yes	83	8 (9.6)				

N=number of positive cases, CI=confidence level, df=degree of freedom

Table 6: Prevalence of urinary schistosomiasis and fresh water contact for domestic and recreational activities

Variable	NE	NP (%)	OR	95% CI	df	Chi-square (p-value)
Washing						
No	217	19 (8.8)	0.731	0.345- 1.550	1	0.671 (0.413)
Yes	183	12 (6.6)				
Bathing and Swimming						
No	184	12 (6.5)	1.382	0.652-2.930	1	0.719 (0.396)
Yes	216	19 (8.8)				
Stream en route						
School/wading						
No	319	26 (8.2)				
Yes	81	5 (6.2)	0.741	0.276-1.995	1	0.353 (0.552)

NE= Number examined, NP= Number positive

Table 7 shows that a highest prevalence of 15.6% was recorded among the population of children who visited freshwater sources for bathing and swimming every day. A prevalence of 12.5% was also observed among children who engaged in seasonal visitation to the stream. Children who responded negatively to swimming or taking a bath in fresh water had a prevalence of 6.5%, while weekly and monthly respondents had 5.8% and 7.7% respectively. There was a zero prevalence of infection among the respondents who visited during the dry season only. There was no statistically significant relationship established, however ($\chi^2 = 7.939, p = 0.160$).

Table 8 shows the relationship between prevalence and intensity of urinary schistosomiasis and haematuria among the pupils. Those who reported haematuria had a prevalence of 22.2% compared to those who did not report any haematuria (4.1%). There was 7.4% heavy infection intensity among the children who reported haematuria as well as 14.8% light infection intensity compared to 0.3% and 3.8% heavy and light infection intensity respectively among children who did not report any haematuria. There was a strong statistically significant association in relation to infection prevalence ($\chi^2 = 29.76, p = 0.000$) as well as intensity ($\chi^2 = 34.035, p = 0.000$).

Table 9 shows the prevalence of urinary schistosomiasis and action taken by the parents/guardians against reported haematuria by the pupils. Children who said they were given herbs had 100.0% prevalence, while those who said nothing was done when they reported had 42.9% prevalence. Those children who were given painkillers had 16.7% prevalence, as well as those who were taken to the chemist. Those who were negative or who did not report haematuria had 4.0% prevalence, while those children who were taken to the hospital had 5.9% prevalence. A strong statistical association was found for action taken against reported haematuria and prevalence of the infection ($\chi^2 = 82.42, p = 0.000$).

The table 10 shows the BMI categories as indicators of nutritional status of the children as compared with World Health Organization (WHO, 2007) reference standard values of BMI for female and male children aged 5-16 years.

Table 11 shows the prevalence of urinary schistosomiasis in relation to the BMI categories established in this study. Of the 227 school children whose BMI values were within healthy weight range, 17 (6.1%) were positive for *Schistosoma haematobium*. Those children at risk of overweight category had 3 (12.0%) of infection status, while those children of the underweight category had 11 (11.2%) infected. There was no statistically significant association of BMI with urinary schistosomiasis ($\chi^2 = 3.294, p = 0.193$).

Table 7: Prevalence of urinary schistosomiasis and frequency of fresh water contact For bathing and swimming

Variable	NE	NP (%)	df	95% CI	Chi-square (p-value)
Frequency of Bathing/swimming					
Dry season	14	0 (0.0)	5	0.102-0.168	7.939 (0.160)
Daily	64	10 (15.6)			
Monthly	26	2 (7.7)			
Nil	184	12 (6.5)			
Weekly	104	6 (5.8)			
Yearly	8	1 (12.5)			

NE= Number examined, NP= Number positive

Table 8: Relationship between prevalence and intensity of urinary schistosomiasis and haematuria among the pupils

Symptoms	NE	NP (%)	OR	95% CI	df	Chi-square (p- p-value)	
Haematuria							
No	319	13 (4.1)	6.73	3.14-14.43	1	29.76 (0.000)	
Yes	81	18 (22.2)					
Intensity (%)							
	Heavy	Light					
No	1 (0.3)	12 (3.8)	319	6.73	0.000 - 0.007	2	34.035 (0.000)
Yes	6 (7.4)	12 (14.8)	81				

NP= number positive, NE= number examined

Table 9: Prevalence of urinary schistosomiasis and action taken by guardians on Reported haematuria

Action taken Against reported haematuria	NE	NP (%)	95% CI	df	Chi- square (p- value)
Given herbs	4	4 (100.0)	0.000 - 0.007	6	82.42 (0.000)
Given pain killer	6	1(16.7)			
Nothing done	14	6 (42.9)			
Negative	322	13 (4.0)			
Others	25	4 (16.0)			
Taking patent to Medicine store	12	2 (16.7)			
Taken patient to hospital	17	1 (5.9)			

NE =Number examined, NP= Number positive, CI=Confidence level, df= degree of freedom

Table 10: Distribution of BMI categories among school Children in Study Population

BMI Categories	Number Examined	Percentage (%)
Normal weight	277	69.3
Risk of Overweight	25	6.2
Underweight	98	24.5
Total	400	100.0

Table 11: Prevalence of Urinary schistosomiasis and BMI Categories in the Study population

BMI Categories	NE	NP (%)	95% CI	df	Chi-square (p-value)
Normal weight	277	17(6.1)	0.149-0.226	2	3.294 (0.193)
Risk of overweight	25	3 (12.0)			
Underweight	98	11 (11.2)			

Discussion

Urinary schistosomiasis is still prevalent in the study area as seen in the findings from this study, with a prevalence of approximately 11.1% among pupils from 11 schools of the total of 28 randomly selected public primary schools in Kubau LGA, Kaduna State. This range falls in the moderate risk category for the infection (10% but $\leq 50\%$ prevalence of infection) according to World Health Organization (WHO) ranking for recommended treatment strategy. There was a zero prevalence of infection recorded among the children in the 10 selected schools in Kaura LGA. Kubau LGA was placed among the low infected area and Kaura among the moderately infected areas for schistosomiasis LGAs respectively in Kaduna State (Federal Ministry of Health, 2015), during the mapping of schistosomiasis and soil transmitted helminth infections in 19 states and the Federal Capital Territory (FCT) in Nigeria. The range of prevalence was, however 1.5-44.2% for Kaduna State LGAs. This implies that although the overall prevalence was between low to moderate for both urinary and intestinal schistosomiasis, some communities still recorded higher prevalence. This was seen in this study among the pupils infected, where infection of *Schistosoma haematobium* in the schools was in the range of 10-70%.

The difference in prevalence recorded in Kubau schools compared to Kaura schools could be because in Kubau LGA, both adults and school children are engaged in all year-round farming (irrigation farming), compared to Kaura LGA, which is done predominantly during the rainy season. In the later, dry season farming is done close to the riverbanks with adults more engaged in these activities as occupation than children. In Egypt, continuous irrigation has been linked to increased prevalence of *S. haematobium* infection in some regions (Barakat, 2012). Ukwubile and Tile (2016) in a study in Bali LGA, Taraba State, Nigeria, attributed the high prevalence of urinary schistosomiasis to dependence on irrigation farming.

The overall prevalence of 7.8% obtained in the two LGAs is lower than that obtained in Kubau LGA alone, and lower than that obtained in Dikwa LGA, North-eastern Nigeria (Balla *et*

al., 2015), in Cross River State (Emini and Enogiomwan, 2019), as well as the current country prevalence of 9.5% (Federal Ministry of Health, 2015). The prevalence obtained in this study is also lower than that found in a recent study in Gwako village in Gwagwalada area council Abuja, Nigeria where a prevalence of up to 31.3% was found (Anyati *et al.*, 2021).

The total prevalence among the genders in the population showed that males had higher prevalence (9.4%) compared to the female children (5.6%). Similar work in Katsina State, Nigeria by Atalabi *et al.* (2016) also recorded high intensity of infection among male children than females. The male children were probably more infected due to both their out-door activities and length of stay in water-based activities like swimming, in addition to irrigation farming activities which are common in a rural community such as in this study. This will also encourage contact with snail infested water which creates the chances for infection (Guirou *et al.*, 2021). Mohammad *et al.* (2019) in their study among school children in Sokoto State, Nigeria, did not find a statistically significant association between gender and *Schistosoma haematobium* infection.

Infection prevalence in this study showed an increase with increasing age, with a statistically significant relationship in the infected age groups ($P = 0.002$). In rural communities engaged in varied farming activities, the older children participate actively alongside with the adult population hence exposing them to snail-infested waters. This could be the reason for the higher prevalence among the older age group in this study. That is, the 11-13- and 14-16-years group compared to those pupils in the 8-10 years group. However, the 8-10 years group recorded more heavy infections compared to the older age groups showing the possibility of early-age and multiple worm infection and reinfection (Poole *et al.*, 2014; Stothard *et al.*, 2014). This differs from findings documented by Mazigo *et al.* (2012) in which ages 14 and higher were more diagnosed with higher intensities of infection. The very young children 5-7 years had no infection probably because of less contact with snail-infested water as well as length of stay compared to their older peers (Houmsou *et al.*, 2018). Variation in infection status among the age group could also be due to reduction in worm burden and clearance of parasite from the pupils from periodic preventive

chemotherapy with praziquantel (Stete *et al.*, 2012). There could also be the development of natural immunity to the infection by the older age group despite reinfection in endemic communities (Sumbele *et al.*, 2021). These findings are similar to those in Jaba LGA, Kaduna State, where younger children aged 4 to 6 recorded zero percent prevalence of infection (Bishop *et al.*, 2016). However, Balogun *et al.* (2022) in Jigawa State, Nigeria, showed in his studies that 5–7-year-olds had the highest prevalence of 80% in communities studied. Studies in Malawi also showed children younger than 5 years can be infected; the risk factor was that they are also exposed to fresh water alongside their mothers, who take them along into the water as they carry out their domestic chores such as washing of cloths, and household cooking items (Poole *et al.*, 2014).

Proximity and contact with fresh water have been named as the factors contributing to the continuous transmission of urinary schistosomiasis in Sub-Saharan Africa due to residence of rural dwellers close to or around open freshwater bodies (Adenowo *et al.*, 2015). The report in this study, however, is consistent with the findings of Ismail *et al.* (2014) who found that there was no statistical significance with water contact and frequency in prevalence and intensities of infection with urinary schistosomiasis. The study revealed however, that children who responded to visiting the fresh water source only during the dry season had zero percent prevalence compared to those who went every day (15.6%), weekly (5.8%), monthly (7.7%), yearly (12.5%), and none (6.5%). This could be because the breeding season for the intermediate host was over and the snails might have gone into dormancy as water level had reduced at the temporary streams and fresh water sources, infection is hence reduced and may occur only randomly (Mazigo *et al.*, 2012).

However, this study has revealed that lack of sanitary facilities in and around most of the schools is a highly likely risk factor to the prevalence as well as intensity of the infection in the most affected schools. This finding is similar to the report of Federal Ministry of Health (Federal Ministry of Health, 2015) in Nigeria, where lack of sanitary facilities was found to be associated with the prevalence of schistosomiasis. This has also been demonstrated in a community in the Gwako district of the Federal Capital Territory, Nigeria, where inadequate safe water as well as personal and public sanitary facilities have led to persistent

urinary schistosomiasis prevalence (Anyanti *et al.*, 2021). In a rural community where sanitary facilities were clearly lacking, and open defaecation was silently encouraged, the chances of nearby freshwater contamination with urine is unavoidable. Lack or inadequate sanitary facilities has been noted for years to impede the successful control of urinary schistosomiasis (Rollinson *et al.*, 2013; Karunamoorthi *et al.*, 2018).

Persistent infection and re-infection by the most at-risk groups such as school children and farmers, may continue to occur and spread to other rural communities through migration. Control approach in this setting may require both treatment of at-risk groups as recommended by the World Health Organization (Stothard *et al.*, 2014) as well as health education on risk factors towards behavioural change on environment and sanitation improvement (Adenowo *et al.*, 2015). An attempt in this regard has been implemented with some success in reducing prevalence to less than 1% in Asia (Rollinson *et al.*, 2013).

Terminal haematuria, which is a symptom of established urinary schistosomiasis (Houmsou *et al.*, 2018; Balogun *et al.*, 2022), was also observed and reported by children in this study. Children who reported haematuria or had blood at the end of urination were more than six times likely to be infected than those who did not report ($P = 0.000$, OR = 6.73). Children in this study also reported haematuria to their parents prior to the study. The action taken by the guardians of these children to the reported haematuria was also statistically significant ($P = 0.000$). Steps taken by them included: giving herbs, seeing a chemist, taken them to a hospital and so on. This implies that the disease is well known but the extent of the impact of the burden of the disease is not fully understood, since some of the children reported "nothing was done" by the parents and sometimes, they are even ignored altogether. Perhaps, it is still being perceived as a normal occurrence for young children and hence may pass with time. Also, poor knowledge of the disease and infection status, and anticipation of quality of treatment or even availability of the drug close to the community to treat the infection, has been noted as a factor for accepting to use unconfirmed means of treatment (Rollinson *et al.*, 2013).

This study also showed that children who reported haematuria to their parents and were taken to the hospital had 5.9% prevalence compared to those who were given herbs, who had 100% prevalence. It means that perhaps the administered herbal concoction did not have any anti-Schistosoma effect. A study by Ukwubile and Tile (2016) in Taraba State, Nigeria, showed that orthodox medicines do not successfully eliminate the disease. Also, the children who reported that 'nothing was done' had 42.9%. Prompt treatment and killing of adult worms at the earlier stages of chronic infection has been noted to be helpful in reversing the morbidity associated with this disease, especially in children (Houmsou *et al.*, 2018; Guirou *et al.*, 2021). In addition, the possibility of spread to other geographical locations through migration and subsequent contamination of fresh water sources by these untreated children is reduced (Utzinger *et al.*, 2015; Karunamoorthi *et al.*, 2018).

This study also observed the presence of *Schistosoma mansoni* eggs in the urine of 2 male children and 1 female child (plate I). This might have been passed through contamination from stool during the collection of the sample or ectopic excretion of a genetic hybrid from interaction of the two species (*Schistosoma haematobium* and *Schistosoma mansoni*) in co infected persons in endemic areas, where they could form heterologous male-female pairs, where the male carries the female worm to its preferred sites for egg-laying. The female worm will hence lay eggs characteristic of her species in an uncharacteristic site, resulting in eggs of *Schistosoma haematobium* been detected in the stool or that of *Schistosoma mansoni* being found in the urine (Loridant *et al.*, 2018; Ojo *et al.*, 2021). The result of studies by Depaquit *et al.* (2019) in Paris showed the case of a 14-year-old male who presented with haematuria, but parasitological test on his urine showed numerous lateral spined eggs characteristic of *Schistosoma mansoni* with the same morphology. *No terminal spine eggs were seen in his urine nor were lateral-spined eggs found in his stool. PCR result showed a case of hybridization between a Schistosoma haematobium male and a Schistosoma mansoni female worm.*

The Body Mass Index of the whole population as a measure of nutritional status has 69.3% in the

healthy weight category, 24.5% in the underweight category and 6.3% were at risk of overweight. The children in the normal weight category had a prevalence of 6.1%, and those children of underweight category had 11.2% while those at risk of overweight had 12%. Abnormal anthropometric indices have been shown to increase the chances of communicable diseases, particularly low values such as in underweight (Dobner and Kaser, 2018). There was, however, no significant association between BMI and infection status in this study. This, however, does not dismiss the fact that the children who are infected with *Schistosoma haematobium* in this study have a high risk of nutritional deficiency and anaemia from haematuria, which could also make them vulnerable to other infectious diseases.

Conclusion

Findings in this study showed a total prevalence of 7.8% among pupils in the study population. Primary school pupils in Kubau LGA had a prevalence of 11.1% infection, and Kaura LGA had zero percent prevalence of infection. Male children were more infected than female children in both status and intensity: 9.4% and 1.3% heavy and 4% light infections compared to 5.6% and 0.5 heavy and 2% light infections. Age group prevalence was seen to increase with increase in age with the younger age groups, 5-7 years having zero percent infection, 8-10 years having 8.1%, 11-13 years having 11.2% and 14-16 years having 22.2%. There was, however, decrease in intensity with age, with 8-10 years group having 1.7% heavy infection and 11-13 years group having 3.4% while 14-16 years had only light infection. The most significant symptom associated with infection with *Schistosoma haematobium* in this study was haematuria where there is more than six times (Bishop *et al.*, 2016) chance of having infection with haematuria than without haematuria. The attitude and behaviours of the parents of children to reported haematuria may also have delayed treatment of the infected children. The unavailability and inadequate sanitary facilities were also seen as a risk factor in the transmission of infection in the population infected, as the children who had no toilets in their school had 13.1% prevalence, OR = 13.2, compared to 1.1% who had toilets in the school environment. This could be the reason for mixed infection evident in eggs of *Schistosoma mansoni* ectopically excreted in the

urine of some children. There was, however, no significant association with toilet availability at home and infection status. Proximity to fresh water sources and contact with such water, frequency of contact, as well as sources of water for domestic and professional use, had no significant association with the infection. BMI was also found not to be significantly associated with the infection in this study.

Conflict of Interest: The authors declare that no conflicts of interest exist.

Author's Contributions

- Charity Nyalian Shemang- Conception and design of the work, acquisition of data, interpretation of data, initial drafting of the work and revising critically for intellectual content and final approval of the copy to be published.
- Helen Ileigo Inabo- Participate in the Initial Conception of the work, analysis and interpretation of data, revising it critically for intellectual content, and approval of the final copy to be published.
- Muhammed Sani Aliyu participated in analysis and interpretation of data, and revised it critically for intellectual content and approval of the final copy to be published.

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