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## Ultrasonography Analysis and Incidence of Urinary Schistosomiasis among some Selected Junior Secondary School Students in Rigachikun, Igabi Local Government Area, Kaduna State, Nigeria

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### Abstract

*This study evaluated urinary schistosomiasis and ultrasonography incidence among school-aged children in Rigachikun, Igabi Local Government Area of Kaduna State. Three hundred urine samples were collected from students within 5-16 years from 3 selected schools. The samples were tested for urinary schistosomiasis, and information was gathered using a standardized questionnaire. The weight and height of the samples were measured using an electronic scale (9201 SV3R) and a portable stadiometer (ADE MZ10042). 5.29% of males and 3.70% of females tested positive for urinary schistosomiasis. Ultrasound examination was performed on ten positive and one negative subjects for confirmation. The mean age was 11.00±5.72 years. Seven out of ten (70%) subjects showed urinary tract abnormalities. The ultrasound findings revealed two out of ten (20%) had bladder wall thickening, four out of ten (40%) had an irregular shape of the bladder wall, and ureteric dilatation was observed in one out of ten (10%) among the subjects. Ultrasound is a useful tool for identifying the morbidity of *S. haematobium*. Schistosomiasis infection amongst schools in Rigachikun was established at 5.00%. This has confirmed that schistosomiasis is still a disease burden amongst school-aged students in Rigachikun and, by extension, all the study area's inhabitants. It can be recommended that further studies need to be carried out on adults and snail intermediate hosts.*

**Keywords:** Anthropometric indices, Incidence, Schistosomiasis, Ultrasonography, Risk Factors.

### INTRODUCTION

The primary cause of Schistosomiasis, sometimes called bilharziasis or snail fever, is eggs from the blood fluke *Schistosoma*, a tropical parasite illness. The German pathologist Theodor Bilharz, who first recognised the worms in 1851, is credited with creating the term bilharziasis (Nawal, 2010; Alhassan, 2013). In endemic regions of Africa, Asia, and South America, schistosomiasis is the second most common tropical parasite illness after malaria and a major source of morbidity (Verjee, 2019). Due to a lack of awareness, certain people in some parts of Africa view the development of haematuria in adolescent boys as a natural condition caused by urinary schistosomiasis (Folahan & Edungbola, 2021).

School-age children typically have the highest prevalence and severity of illness, leading to estimations of substantial morbidity and mortality in affected populations (Glynn and Moss, 2020). According to Nelwan (2020), there are an estimated 200 million *S. haematobium* infections worldwide, with 70% of cases

occurring in sub-Saharan Africa. The study of Onyekwere (2022) observed that Nigeria has a large prevalence of schistosomiasis; in many of the country's northern and southwestern states, it is hyper-endemic, whereas in the southeast, it is moderately to lowly endemic. Most endemic foci are home to *Schistosoma haematobium*, but *S. mansoni* is primarily found in the north and a few areas of the southwest. Ahmad et al., (2021) posited that Nigeria has the highest prevalence of urinary schistosomiasis, with an estimated 101.28 million people at risk and 25.83 million cases of infection. According to studies conducted in Nigeria, as reported by Abbas et al. (2023), schistosomiasis is an issue that affects school-age children in both rural and urban settings, with infection rates ranging from 20 to 40 percent in most communities. Akbar (2020) in his research noted that students with schistosomiasis perform poorly academically, and in severely afflicted areas, the debilitation brought on by untreated illnesses impedes social and economic growth.

In tropical and subtropical regions, schistosomiasis is common, particularly in impoverished populations lacking access to clean water for drinking and proper sanitation. At least 90% of people with schistosomiasis who need treatment are thought to reside in Africa. Public schools, the majority of which have more than 3,900 students, lack a sufficient water supply and sanitary facilities, leading to students frequently using the area around the playground for defecation (Folahan, 2021). As a result, when students visit the streams, they encounter the infectious stages of schistosome parasites. To our knowledge, Rigachikun, Igabi L.G.A. has no data on anthropometric and ultrasonographic parameters of urinary schistosomiasis prevalence. In this work, using ultrasonography helps highlight the harmful effects caused by schistosomiasis. Thus, this study aimed to examine the ultrasonographic features associated with *Schistosomiasis* in the urinary tract of school-aged children in Rigachikun, Igabi L. G. A. of Kaduna.

## MATERIALS AND METHODS

The research was conducted within primary and junior secondary schools in Rigachikun, Igabi Local Government Area of Kaduna State, Nigeria. Igabi Local Government Area (LGA) is one of the twenty-three LGAs in Kaduna State, with its headquarters at Doka. Rigachikun and Rigasa are among the most densely populated wards within Igabi LGA. Situated less than five Kilometres from the Kaduna capital, Igabi LGA constitutes approximately 40% of the Kaduna metropolis (Ekwunife *et al.*, 2009). Geographically, Igabi LGA is positioned at latitude 10°48'21.71"N and longitude 7°42'51.95"E, covering an area of 3,727 km<sup>2</sup> and hosting a population of 430,753 as per the 2006 census. The residents of Igabi LGA engage in various occupations such as trading, farming, tailoring, cattle rearing, and civil service. Wells, streams, and boreholes serve as the primary drinking water sources for households in these communities. However, there is a prevalent inadequacy in potable water supply,

$$n = \frac{Z^2pq}{L^2}$$

Where,

n = Minimum sample size

Z = Standard normal distribution at 95% confidence interval = 1.96

p = Prevalence rate, which is taken as 25% = 0.25

q = 1- p = 0.75

L = allowable error, which is taken as 5% = 0.05

Based on the formula above, a minimum of 285 school-aged samples were estimated. Therefore, for this study, a total of 300 urine samples were collected according to the method

with a significant portion of the populace still relying on natural water sources like streams, rivers, and ponds. Consequently, the region grapples with poor sanitary conditions, posing health risks such as susceptibility to infectious diseases like schistosomiasis (Ekwunife *et al.*, 2009).

## Sample Population

Children enrolled in primary and junior secondary schools in the Rigachukun ward of the Igabi Local Government Area, Kaduna State, Nigeria, aged five to sixteen, are included in the study population.

## Ethical Clearance and Permission to carry out the Study

An introduction letter was received from Ahmadu Bello University, Zaria, Nigeria's Department of Biology, Faculty of Life Sciences. An approval letter was received from the Igabi Local Government Education Authority to carry out the study. Prior to collecting the samples, the parents of the enrolled children were asked for their signed agreement. The study only included participants who provided informed consent to participate in the investigation. Likewise, Ahmadu Bello University's Zaria committee granted ethical clearance for using human and animal samples.

## Administration of Questionnaires

Each participant was given a standardized questionnaire to gather anthropometric and socio-demographic information. The information obtained includes name, sex, age, height, class, name of the School, parental occupation, source of water supply, type of toilet used, and water contact activities. The questionnaire was administered and interpreted to the children in both Hausa and English.

## Determination of Sample Size

Using the following equation, the sample size was calculated according to Alhassan *et al.* (2013)'s method:

of Okpala *et al.* (2004) from pupils in primary and students of Junior Secondary Schools in Rigachukun, Igabi L. G. A. Kaduna State, Nigeria.

### Study Population

The subjects of primary and junior secondary schools made up the study population. Three (3) schools—L. G. E. A. Primary School Rigachikum II, Mallam Jallo Model Primary School, and Government Day Junior Secondary School Rigachikum—were used to gather the subject's urine samples. There is a creek near Mallam Jallo Model Primary Schools where students frequently go to swim, take showers, and do laundry. One hundred (100) urine samples were randomly drawn from each School's student body.

### Sampling Procedures

With parental or guardian permission, 300 randomly selected urine samples from school-age male and female students were taken. To gather demographic information, a standardised questionnaire was given to each participant. The following details were gathered: age, height (measured with a metre ruler), weight (measured using a weighing balance), sex, educational background, awareness of symptoms, water supply sources, mechanism of transmission, and health effects of schistosomiasis (WHO, 2005). The recruited subjects were handed urine vials that had been labelled and sterilised so they could collect pee samples. The collecting took place from 10:00 a.m. to 12:00 p.m. The collected urine was sent in a cool box for laboratory analysis immediately to the Department of Zoology, Parasitology and Entomology Laboratory, Ahmadu Bello University Zaria, Nigeria.

## PARASITOLOGICAL ANALYSIS

### Urine Sample Analysis

Urine sample analysis was conducted using the filtration process. Five minutes were spent centrifuging ten (10 ml) of the urine in the centrifuge tube at 1,500 rpm. The sediment was moved onto a microscopic slide using a micropipette, and the supernatant was disposed of (Jibril, 2017). The preparation was covered with a coverslip, which was then viewed under an x10 objective and confirmed under an x40 objective microscope lens. A drop of Lugol's iodine was added to the preparation.

### Identification of the Parasites

Parasite eggs/ova were observed and identified using the Atlas developed by Soulsby (1982).

### Ultrasonographic Examination of Infected Pupils

A total of 15 subjects (13 males and 2 females) who were positive for urinary schistosomiasis eggs were subjected to ultrasonography. Ultrasound was performed on 10 positive subjects, while the other 5 subjects were absent during the ultrasound screening. This may be

because their parents did not allow them to participate.

The students' average age was  $11.00 \pm 5.72$  years. In an Islamic hospital in Kawo, Kaduna, Nigeria, sonologists assisted in doing ultrasonographic tests using gel and a portable ultrasound device (Digital WED 160 portable ultrasound with a 2.5-6 MHz curvilinear probe). Depending on the child's age, each one was given between 0.1 and 1.5 litres of water thirty minutes to an hour before the examination to ensure their bladder was full. By positioning a probe above the pubic symphysis at the bladder's maximal cross-sectional diameter, it was possible to examine them transversely and see the distal portion of the ureters. Sector scanning was used to identify urinary tract disease, which was then assessed in accordance with established procedures O'Bryant (2023). Urinary tract imaging was carried out once the bladder was fully filled and well hydrated. Post-voiding pictures were acquired for individuals exhibiting anomalies related to the kidneys, ureters, or bladder. The outcome was recorded using the S.heamatobium (module 1) record sheet for ultrasonography results.

### Data Analyses

Descriptive statistics were employed to assess the percentage of individuals exhibiting positive results. The intensity of infection was determined using the formula outlined by Mergo and Crites (1986). Chi-square analysis was utilized to ascertain the association between demographic and anthropometric indices and the incidence of infection. The body mass index (BMI) of the infected school-aged students was used to define the relationship between height, weight (anthropometric indices), and incidence of infection. World Health Organization (WHO, 2010) standard was used to score the ultrasonographic abnormalities. Odds ratio (OR) was used to determine the association between the risk factors and with incidence of the infection, and the significance level was determined at 95% ( $p \leq 0.05$ ) confidence interval (C.I).

## RESULTS

Table 1 displays the prevalence of urinary schistosomiasis in school-age children in Rigachikum. A total of 300 students were examined, of which 15 were infected, representing 5% of the study population. One hundred children were examined in each School. The highest infection incidence was recorded by students at Junior Secondary School Rigachikum (7.00%), while the lowest incidence was recorded by students at LGEA Rigachikum II and Mallam Jallo Primary School (4.00%). In the sampled three Rigachikum schools, pupils showed an overall frequency of 5.00%.

Between the three schools, there was no statistically significant variation in urine schistosomiasis ( $p > 0.05$ ).

The prevalence of schistosomiasis in school-age children in Rigachikun is displayed in Table 2. The age group with the highest incidence of schistosomiasis infection was 13-16 years old

(14.29%), followed by 9-12 years old (6.67%) and 5-8 years old (4.02%). The age group below five years old was not infected. In Rigachikun, no statistically significant ( $p < 0.05$ ) correlation was seen between the infection and school-age children.

**Table 1: Incidence of Urinary Schistosomiasis among School-aged Children in Rigachikun**

Schools/LGEA	No. examined	No. Infected	Prevalence (%)
Rigachikun II	100	4	4.00
Mallam Jallo	100	4	4.00
Junior Sec. School	100	7	7.00
Total	300	15	5.00
	Chisquare	1.263	
	Df	2	
	P-value	0.532	Ns

Ns = Not significant

**Table 2: Age related Incidence of Schistosomiasis among School-aged Children in Rigachikun**

Age (year)	No. examined	No. infected /Prevalence (%)	Chisquare	P-value
≤ 05	4	0 (0.00)	2.410	0.492
5-8	199	8 (4.02)		
9-12	90	6 (6.67)		
13-16	7	1 (14.29)		
Total	300	15 (5.00)		

**Relationship between Anthropometric indices and incidence among school-aged children in Rigachikun**

Table 3 presents the incidence of urinary schistosomiasis in relation to the BMI of school-aged children. The BMI of infected school-aged children was utilized to explore the relationship between height, weight, and the incidence of urinary schistosomiasis. BMI categories were defined as <18 for underweight, 18-24.5 for normal weight, 25-29.5 for overweight, and 30 and above for obese. No infections were observed in the underweight category. Among those with a BMI of 18-24.5, there were 6 (3.02%) cases of urinary infection, with 4 (2.01%) in males and 2 (1.01%) in females. In the BMI range of 25-29, there were 8 (8.89%) cases of urinary schistosomiasis infection in males, and for those with a BMI of >30, there was 1 (14.29%) infection in males.

Table 4 depicts the relationship between anthropometric indices and the incidence of urinary schistosomiasis among school-aged

children in Rigachikun. A strong positive and significant correlation ( $r = 0.922$ ) was observed between weight and age of the students. Similarly, height and age had a significant and positive correlation ( $r = 0.893$ ). Height and weight were also significantly and positively correlated ( $r = 0.897$ ). Furthermore, positive correlations were observed between height square and age ( $r = 0.897$ ), height square and weight ( $r = 0.913$ ), as well as height factor and height (0.996). Body mass index (BMI) showed a positive and significant correlation with age ( $r = 0.625$ ) and weight (0.764). Additionally, weak correlations were observed between the incidence of urinary schistosomiasis and various anthropometric indices. There was a weak positive correlation ( $r = 0.001$ ) between incidence and age, while the correlations between incidence and weight ( $r = -0.238$ ), incidence and height ( $r = -0.194$ ), incidence and height square ( $r = -0.223$ ), and incidence and BMI ( $r = 0.179$ ) were all weak and negative.

**Table 3: Incidence of Urinary Schistosomiasis in Relation to Body Mass Index (BMI) of School-aged children in Rigachikun**

Range of Body Mass Index (BMI)	Number of males infected (%)	Number of females infected (%)	Total number infected (%)
< 18	0 (0.00)	0 (0.00)	0 (0.00)
18-24.5	4 (2.01)	2 (1.01)	6 (3.02)
25-29.5	8 (8.89)	0 (0.00)	6 (8.89)
> 30	1 (14.29)	0 (0.00)	1 (14.29)
Total	13 (4.33)	2 (0.67)	15 (5.00)

**Table 4: Relationship between Anthropometric Indices and Incidence of Urinary Schistosomiasis among school-aged children in Rigachikun**

Variables	Age	Weight	Height	H <sup>2</sup>	BMI	Prevalence
Age	1.000					
Weight	0.922**	1.000				
Height	0.893**	0.897**	1.000			
H <sup>2</sup>	0.897**	0.913**	0.996**	1.000		
BMI	0.625*	0.764**	0.414	0.439	1.000	
Prevalence	0.001	-0.238	-0.194	-0.223	-0.179	1.000

\* = Significant at P ≤ 0.05

\*\* = Significant at P ≤ 0.01

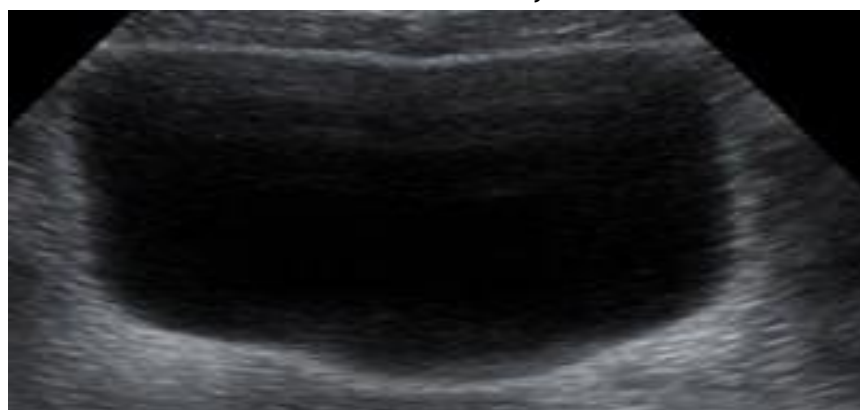
**Ultrasound Findings**

The average age of the ten infected subjects was 11.00±5.72 years. Seven out of ten (70.00%) of these subjects exhibited urinary tract abnormalities. [Plate I](#) displays a normal urinary bladder, while the findings indicated that 2 out of 10 (20.00%) subjects exhibited urinary bladder wall thickening, as depicted in [Plate II](#). None of the subjects displayed urinary bladder polyps, and there were no observations of bladder wall calcification. As shown in [Plate III](#), ureteric dilatation was observed in 1 out of 10 (10.00%) subjects.

Furthermore, irregularities in the shape of the bladder wall were detected in 4 out of 10 (40.00%) subjects, as illustrated in [Plate IV](#). It is noteworthy that the majority of urinary tract schistosomiasis lesions were localized in the urinary bladder. Ultrasound imaging proved to be a valuable tool in assessing the morbidity associated with *S. haematobium* infection.

**Risk Factors Associated with Urinary Shistosomiasis among the School-aged Children in Rigachikun**

The risk factors associated with urinary schistosomiasis among school-aged children in Rigachikun are presented in [Table 5](#). The incidence of infection among those who used pipe-borne water revealed that they were 3.049 times more likely to contract schistosomiasis, whereas there was no association between the use of borehole water and the incidence of urinary schistosomiasis (OR = 0.96%). The use of pit latrines was not statistically significant in relation to the incidence of schistosomiasis; similarly, those who used water closets did not exhibit increased odds (0.810) of infection. The presence of ponds close to residential areas was not significantly associated with urinary infections. However, individuals residing near ponds were 1.138 times more exposed to the infection than those who did not have ponds nearby.



**Plate I: Normal Urinary Bladder**



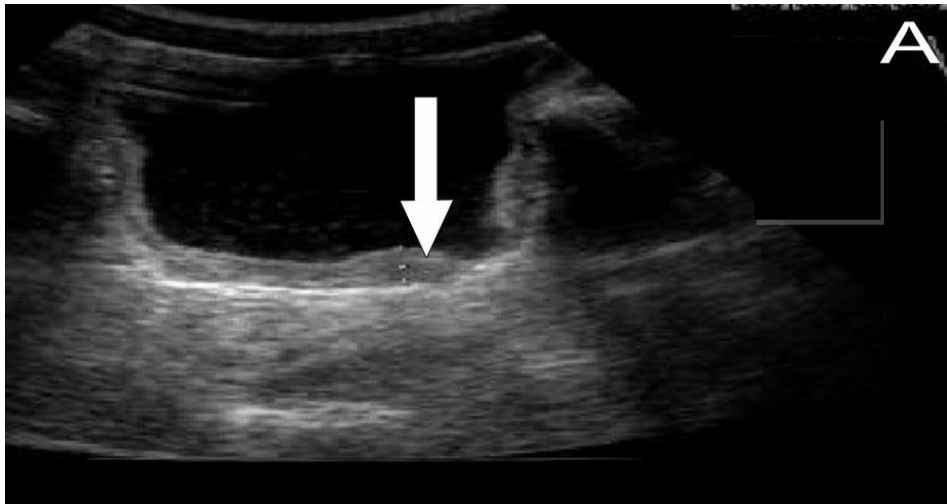


Plate II: Urinary Bladder Wall Thickening

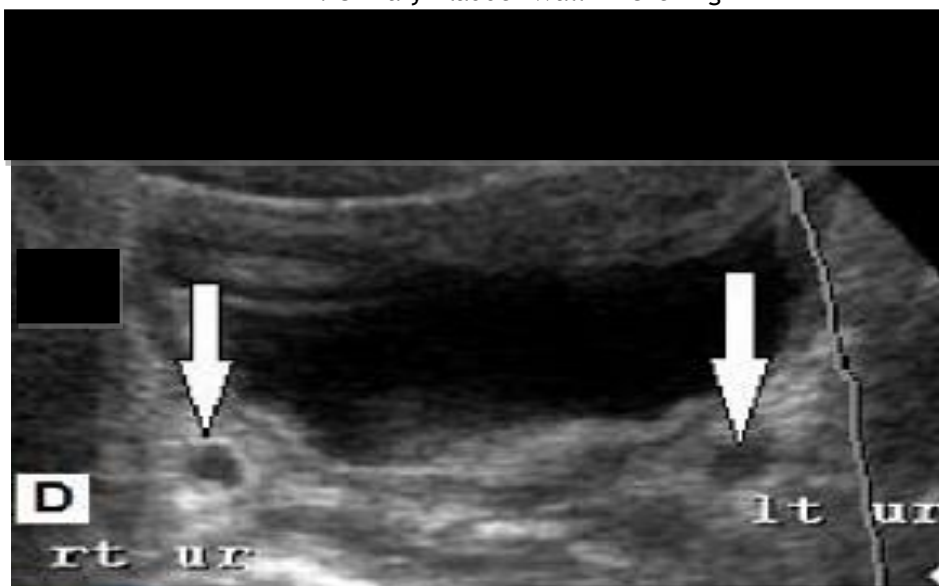


Plate III: Axial View of Urinary Bladder Showing Bilateral Ureteric Dilation

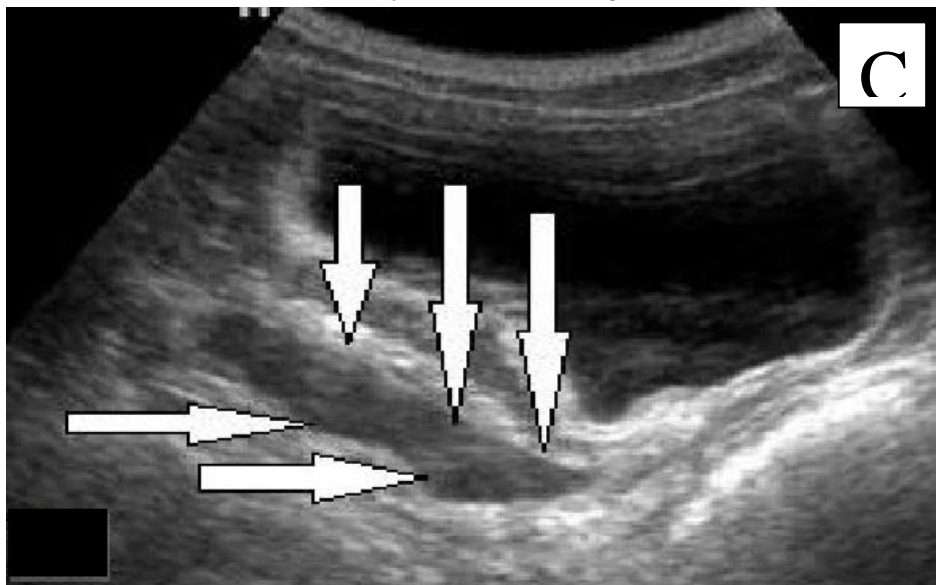


Plate IV: Irregular Shape of the Bladder Wall

The activities of the subjects were not significantly associated with urinary schistosomiasis infection. Among subjects who played in the pond, the incidence was 2.70%, with 2.294 times the odds of infection. Those who swam in the pond had a prevalence of 11.54%, with a risk of 0.364. Using water bodies for fishing resulted in an incidence of 10.53% with a risk of exposure of 0.427. Subjects who took cattle for watering had an incidence of 33.33%, with odds of schistosomiasis infection at 0.102. However, those who did not participate

in these activities were 0.616 times less exposed. The presence of blood in urine was not significantly associated with urinary schistosomiasis. Individuals with blood in their urine were 1.015 times more likely to contract urinary schistosomiasis infection. The scores of infected subjects among school-aged children in Rigachikun are shown in Table 6, where there were 2 male and 2 female subjects, each with bladder wall thickening, 3 males with irregular bladder shape, and 2 males with ureteric dilation.

**Table 5: Risk Factors Associated with Schistosomiasis among the Schools in Rigachikun**

Risk factor	No. examined	No. infected (%)	No. negative (%)	Chi-square	Df	P-value	Odds ratio	95 % CI
<b>Water source</b>								
Pipe borne	93	2 (2.15)	91	2.304	3	0.129	3.049*	0.674-13.793
Well	103	8 (7.77)	95	2.528	3	0.112	2.286*	0.805-6.492
River/stream	2	0 (0.00)	2					
Borehole	102	5 (4.90)	97	0.969	3	0.203	0.969	0.322-2.915
Total	300	15 (5.00)	285					
<b>Faecal disposal</b>								
Bush	11	0 (0.00)	11					
Pit latrine	238	12 (5.04)	226	0.139	2	0.710	1.044*	0.285-3.821
Water closet	51	3 (5.88)	48	0.101	2	0.751	0.810	0.220-2.980
Total	300	15 (5.00)	285					
<b>Presence of pond</b>								
Yes	208	10 (4.81)	198	0.053	1	0.818	1.138*	0.378-3.428
No	92	5 (5.43)	87	0.053	1	0.818	0.879	0.292-2.647
Total	300	15 (5.00)	285					
<b>Activities</b>								
Play	74	2 (2.70)	72	1.220	3	0.269	2.294*	0.505-10.413
Washing	11	0 (0.00)	11					
Swimming	26	3 (11.54)	23	2.380	3	0.123	0.364	0.096-1.382
Fishing	19	2 (10.53)	17	1.20	3	0.273	0.427	0.089-2.046
Watering cattle	3	1 (33.33)	2	4.923	3	0.026	0.102	0.009-1.196
None	169	7 (4.14)	162	0.845	3	0.358	0.616	0.217-1.746
Total	300	15 (5.00)	285					
<b>Blood in urine</b>								
Yes	121	6 (4.96)	115	0.001	1	0.978	1.015*	0.352-2.928
No	179	9 (5.03)	170	0.001	1	0.978	0.986	0.342-2.844
Total	300	15 (5.00)	285					

Table 6: Scores of infected School-aged Children in Rigachikun

Questionnaire Number	Sex	Number of eggs	Abnormality	Score
120	F	72	Bladder wall thickening	2 (Mild)
198	M	51	Bladder wall thickening	2 (Mild)
72	M	106	Irregular Shape of the Bladder	1 (Severe)
247	M	132	Irregular Shape of the Bladder	1 (Severe)
22	M	382	Irregular Shape of the Bladder	1 (Severe)
233	M	297	Irregular Shape of the Bladder	1 (Severe)
205	M	23	Dilation	2 (Moderate)
Total		1063		10

Key: M = Male, F = Female

### CONCLUSION

The incidence of urinary schistosomiasis was 5.00% among School-aged children, with ages 13-16 years having the highest prevalence (14.29%). Ultrasonographic examination revealed that positive samples showed bilateral ureteric dilation, bladder wall thickening, and irregular shape of the bladder wall and the use of pipe-borne water (OR = 3.049), well water (OR = 2.286), presence of pond close to residential areas (OR = 1.138), pit latrine (OR = 1.044), playing in the ponds (OR = 2.294) and presence of blood in urine (OR = 1.015) all showed

correlation with school-age children's urine schistosomiasis incidence in Rigachikun.

### Recommendations

Based on the result of this study, the following recommendations are made:

To minimise interaction with contaminated waterways, pipe-borne water access is required for all schools in the Rigachikun area, and further studies should be carried out to evaluate the level of urinary schistosomiasis in adults, as this study did not cover them.

### REFERENCES

- Abbas, U., Eberemu, N. C., Orpin, J. B., & Kaware, M. S. (2023). Human Water Contact Behaviour and *Schistosoma haematobium* Infection among Almajiri School Children in Kurfi Local Government Area of Katsina State, Nigeria. *Nigerian Journal of Parasitology*, 44(1). [Crossref]
- Ahmed, N. Y., Bashir, A., & Buhari, Y. (2021). Prevalence and Risk factors of Urinary Schistosomiasis among Secondary School Students in Dutsinma Local Government Area of Katsina State. *UMYU Journal of Microbiology Research (UJMR)*, 6(2), 108-114. [Crossref]
- Akbar, S. (2020). Handbook of 200 medicinal plants: a comprehensive review of their traditional medical uses and scientific justifications.
- Alhassan, A. (2013). Prevalence of Schistosomiasis Among Primary School Pupils in Birnin-Gwari Local Government Area, Kaduna State. *A Thesis Submitted to the School of Postgraduate Studies, Ahmadu Bello University, Zaria in Partial Fulfilment of the Requirements for the*
- Award of a Master Degree in Biology (Education). Department of Biological Sciences, Faculty of Science, Ahmadu Bello University, Zaria Nigeria*, Pp. 1-23.
- Ekwunife, C.A., Okafor, F.C. and Nwaorgu, O.C. (2009). Ultrasonographic screening of urinary schistosomiasis infected patients in Agulu community, Anambra state, southeast Nigeria. *International Archive of Medicine*, 2:34. [Crossref]
- Folahan, F. F., Edungbola, L. E., & Folahan, J. T. (2021). Prevalence of Urinary Schistosomiasis Among Primary School Pupils. *Journal of Microbiology and Infectious Diseases*, 11(02), 95-104. [Crossref]
- Glynn, J. R., & Moss, P. A. H. (2020). Systematic analysis of infectious disease outcomes by age shows lowest severity in school-age children. *Scientific data*, 7(1), 329. [Crossref]
- Jibril, J. (2017) Prevalence of Urinary Schistosomiasis Among Public Schools in Rigachikun, Igabi Local Government Area of Kaduna State, Nigeria. A paper presented at 12<sup>th</sup> annual conference of



Zoological Society of Nigeria (ZSN), Federal University of Technology, Minna.

Mergo, J.C. and Crites, J. L. (1986). Prevalence, Mean Intensity, and Relative Density of Lintaxine Cokeri Linton 1940 (Monogenea: Heteraxinidae) on Freshwater drum (*Aplodinotus grunniens*) in Lake Erie (1984). *Ohio Journal of Science*, **86**(3): 101-105.

Nawal, M.N. (2010). Schistosomiasis: Health effects of Women. *Reviews in Obstetrics and Gynecology*, **3**: 28-32.

Nelwan, M. (2020). *Schistosoma haematobium*. Available at SSRN 3695850. [Crossref]

O'Bryant, M. S. (2023). *Educational Intervention: Improving Long-Term Care Nursing Staff Comfort with Utilizing Bladder Scanner* (Doctoral dissertation, The University of North Carolina at Greensboro).

Okpala, H.O., Agwu, E., Agba, M.I., Chimezie, O.R., Nwobu, G.O. and Ohihoin A.A. (2004). A Survey of Prevalence of Schistosomiasis Among Pupils in Apata and Laranto Areas in Jos, Plateau State. *Online Journal of Health Allied Sciences* **3**(1): 1-4.

Onyekwere, A. (2022). *Population genetic structure and hybridization of urogenital*

*schistosomiasis among primary school-age pupils in Nigeria* (Doctoral dissertation, Université de Perpignan). [Crossref]

Richter, J., Hatz, C., Campagne, G., Bergquist, N.R. and Jenkins, J.M. (2000). *Ultrasound in Schistosomiasis: A Practical Guide to the Standardized Use of Ultrasonography for the Assessment of Schistosomiasis-related Morbidity*, World Health Organization, Geneva, 49 pp.

Soulsby, E.J.L. (1982). *Helminths, Arthropods and Protozoa of Domesticated Animals*, 7th ed. Bailliere Tindall, London. 809P.

Verjee, M. A. (2019). Schistosomiasis: still a cause of significant morbidity and mortality. *Research and reports in tropical medicine*, 153-163. [Crossref]

World Health Organisation (2005). "Schistosomiasis control in china the impact of a 10 years world ban loan project (1992-2001)" *an International Journal of Public Health*, **83**(1): 44-48.

World Health Organisation (2010). *Schistosomiasis, Fact Sheet, No. 115.WHO Technical Report Series, 912: 1-57.*