**Original Research Article**

# Prevalence of urinary schistosomiasis among primary school pupils in Jos, Northcentral Nigeria.


## ABSTRACT

**Background**: Urinary schistosomiasis is a parasitic disease caused by *Schistosoma haematobium.* It is a neglected tropical disease with Africa responsible for an estimated 90% of all cases requiring treatment. Nigeria is known to be endemic for urinary schistosomiasis with more than 100 million people at risk and about a 25million already infected.

**Aim**: This study aimed to determine the prevalence and associated risk factors of urinary schistosomiasis among primary school pupils in Jos, Northcentral Nigeria.

**Study Design**: A cross-sectional school-based study of 264 primary school pupils in Jos, Northcentral Nigeria.

**Place and Duration of Study**: September 2021 to February 2022.

**Methodology**: About 50ml of terminal urine samples were collected from each pupil in a sterile, wide-mouth universal container after obtaining consent from their parents and filling out a structured questionnaire. Urinalysis was done on-site using Swe-Care Uric 9V Urinalysis Reagent Strip. The ova of *Schistosoma haematobium* were identified using microscopy. DNA extraction was done on the positive sample and stored for subsequent sequencing. Statistical analysis was done using Statistical Package for Social Sciences (SPSS) version 22.

**Results**: The eggs of *Schistosoma haematobium* were observed in 43(16.3%) of 264 urine samples examined. School B had the highest prevalence of 30.8% followed by School A, while School C with the highest number of recruited pupils was responsible for the lowest prevalence rate at 5(7.1%). Males were more infected than females with the age group 11-13 years old accounting for the highest prevalence rate of 15(25.9%). Haematuria and dysuria were found to have a positive correlation with urinary schistosomiasis among the participants.

**Conclusion**: The findings of this research revealed that urinary schistosomiasis is still a major concern among primary school pupils in Jos, Northcentral Nigeria. Preventive chemotherapy using praziquantel should be combined with health education and communication strategies to treat and change risky behaviours among infected pupils such as swimming in snail-infested freshwater.

**Keywords:** Cercariae, Microscopy, Praziquantel, *Schistosoma haematobium,* Terminal haematuria

## 1. INTRODUCTION

Urinary schistosomiasis is a parasitic disease caused by the blood fluke *Schistosoma haematobium*. This parasite lives in the vesical plexus of the infected individuals and releases eggs that penetrate the bladder mucosa using proteolytic enzymes, aided by their terminal spines to gain access into the bladder lumen [1].Although a preventable disease, urinary schistosomiasis ranks second only to malaria in terms of the prevalence and socio-economic impact of parasitic diseases in tropical and subtropical countries where it is endemic. The distribution of the disease is focal and its effects are more common in rural areas where the population uses natural fresh water for their domestic water supply, recreational activities, and agricultural production. Hence, disease transmission is contingent on the presence of freshwater infested with the infected freshwater snail Bulinus; the intermediate host [2,3].

The high prevalence of urinary schistosomiasis has been attributed to the wide distribution of the intermediate host; freshwater snails. Indiscriminate micturition, poor sanitation, poverty, ignorance, and limited access, and availability of health facilities are factors that sustain the persistence of urinary schistosomiasis in developing countries [4]. The report for 2021 indicated that 29.9% of people requiring treatment were reached globally, with a proportion of 43.3% of school-aged children requiring preventive chemotherapy for schistosomiasis being treated. A drop of 38% compared to 2019, was due to the COVID-19 pandemic which caused the suspension of treatment campaigns in many endemic areas [5]. Urinary schistosomiasis is a serious health problem in Nigeria, with about 29 million infected cases and 101 million people at risk of infection [6].

Patients with urinary schistosomiasis often present with haematuria or blood in urine with progressive damage to the bladder, ureters, and kidneys [7,8]. School children, adolescents, and young adults have been found to have the highest prevalence and morbidity rate due to Schistosomiasis. The negative impacts caused by untreated infections demoralize both the social and economic development of school performance among infected children in endemic areas [9]. It causes growth retardation, anaemia, vitamin- A deficiency as well as possible cognitive and memory impairment, which limits their learning potential [10].

The negative impact of this infection has warranted the need for continuous surveillance and treatment to curtail the health implications. The WHO strategy for schistosomiasis control focuses on reducing disease through periodic, large-scale treatment of at-risk populations with praziquantel [5]. However, this has suffered serious neglect in most developing countries due to financial constraints. This necessitated the need for this study to draw the attention of policymakers to the challenges faced by sufferers of this infection.

## 2. MATERIALS AND METHOD

### 2.1 StudyArea

A cross-sectional school-based study was conducted among primary school pupils in Jos South Local Government Area of Plateau State**.** Most of thechildren attending these schools live with their parents and guardians within the surrounding communities of the study area. The people living in this community are mainly civil servants, farmers, traders, and artisans. There are many abandoned mining ponds in the study area that the residents use for irrigation farming, washing clothes, swimming and as sources of water for domestic use.

The study area was selected purposely, while the five schools were selected by ballot without replacement out of the total of ten schools in the area. All the selected schools are government-owned day schools. The sample size was distributed to the five selected schools proportionately taking into consideration the total number of students in each school. The students were finally recruited by using a simple paper balloting containing “YES” or “NO,” and those who picked YES were recruited into the study.

Terminal urine samples were collected from 264 primary school pupils, using well-labelled 50ml sterile, wide-mouth, screw-capped plastic containers after giving them instructions on how to collect the terminal urine, andfilling out a self-administered, structured questionnaire. The samples were transported in the cold box containing ice blocks and transported to the laboratory within 10 minutes of collection and analyzed immediately. The samples were divided into two portions, the first portion was stored at -20$^{o}$C for polymerase chain reaction (PCR) while the second portion was used for Urinalysis and microscopy.

### 2.2 Urinalysis

Urinalysis of the urine samples was done for microhaematuria using Swe-Care Urinalysis Reagent strips following the manufacturer's procedure. The reagent strip was dipped into the urine sample for 2 seconds, taken out, and left over the bench for about one minute. Finally, the reagent strip colour was compared with the chromatic scale provided by the manufacturer. The result was recorded and graded as negative (0), trace (±), small (1+), moderate (2++), and large (3+++) according to the manufacturer's instructions[11].

### 2.3 Urine Filtration and Microscopy

Urine filtration technique was performed using a polycarbonate membrane filter with 12 μm pore size (SterliTech corporation, USA), Swinnex polypropylene filter holder (SterliTech corporation, USA), and 10 ml plastic syringe. After thorough mixing, 10 ml urine was taken by syringe and filtered through the polycarbonate membrane filter. The filter was then removed with sterile forceps placed on a clean glass microscope slide and examined under a 10X objective lens of a light microscope for *Schistosoma haematobium* eggs. The number of eggs obtained per 10 ml of urine specimen was counted and recorded. The intensity of infection was expressed as egg count per 10ml of urine. The intensity of infection was classified as light (< 50 eggs/ 10 ml of urine) or heavy (≥ 50 eggs/10 ml of urine) [12].

## 3. STATISTICAL ANALYSIS

The results obtained were analyzed using Statistical Package for Social Sciences (SPSS) version 26 (IBM SPSS Inc, Chicago, IL, USA).

## 4. RESULTS

The study revealed that 43(16.3%) out of the 264 pupils examined had urinary schistosomiasis with School B having the highest prevalence rate (30.8%), followed by School-A (27.3%). School D and School E had a prevalence of 15(12.0%) and 5(10.0%) respectively. Although School C had the highest number of respondents, it had the least prevalence of 5(7.1%). This was statistically significant [Table 1] ($P$ = 0.002, $\chi^2$ = 17.283).

The infection was more among males than females with a prevalence of 29(17.7%) and 14(14.0%) respectively. For the male patients, the infection was higher among the age group 11-13 years (25.9%) compared to the age group 8-10 years (22.2%) among the female patients. Generally, the age group 11-13 years were the most infected among the studied population followed by the age group ≥14 years. The age groups 5-7 years and 8-10 years had the least prevalence rate of 14.0% each. This was not statistically significant [Table 2] ($P$= 0.23, $\chi^2$ = 4.329).

Swimming in Rivers/Ponds was found to be significantly associated with urinary schistosomiasis at $P$< 0.001. Sixty of the respondents confirmed swimming in rivers or ponds of which 41(68.3%) had urinary schistosomiasis. Washing of clothes in rivers or ponds also recorded a significant association with urinary schistosomiasis. Twenty-two (26.8%) out of 88 respondents who go to the rivers or ponds to wash their clothes, were positive for urinary schistosomiasis. Other risk factors that were evaluated and not found to be significant were awareness of urinary schistosomiasis, sources of water for domestic uses, and type of toilets used at home [Table 3]. The use of prophylactic praziquantel had no significant correlation with urinary schistosomiasis in this study. Only 14 of the respondents had taken praziquantel within the last two weeks before the sample collection and 1(7.1%) was positive for the eggs of *Schistosoma haematobium.* This was not statistically significant as compared to those who have not taken the medication

Table 4 shows symptoms associated with Urinary Schistosomiasis among the study population. The commonest symptom among the pupils was terminal haematuria. Out of 78 respondents who complained of terminal haematuria, 28(35.9%) had urinary schistosomiasis. This was statistically significant at $P$<0.001 (Table 4). Fifty-six respondents had dysuria with 17(30.4%) testing positive for *Schistosoma* *haematobium* [Table 4] (*P* = 0.001, $\chi^2$= 10.319). Lower abdominal pain was recorded among 125 respondents of which 22(17.6%) had urinary schistosomiasis. This as well as urinary frequency was not significantly associated with urinary schistosomiasis [Table 4].

**Table 1: Prevalence of urinary schistosomiasis among primary school pupils.**

| Schools | No. Examined | No. Positive (%) |
|---|---|---|
| A | 55 | 15(27.3) |
| B | 39 | 12(30.8) |
| C | 70 | 5(7.1) |
| D | 50 | 6(12.0) |
| E | 50 | 5(10.0) |
| **Total** | **264** | **43(16.3)** |

$\chi^2$= 17.283, *P*= 0.002, df = 4

**Table 2: Age and sex distribution of urinary schistosomiasis among primary school pupils in Jos, Northcentral Nigeria.**

| | Males | | Females | | Total |
|---|---|---|---|---|---|
| **Age group** | **No. Tested** | **No. Positive (%)** | **No. Tested** | **No. Positive (%)** | **No. Positive (%)** |
| 5-7 | 29 | 4(13.8) | 20 | 2(10.0) | 6(14.0) |
| 8-10 | 24 | 2(8.3) | 18 | 4(22.2) | 6(14.0) |
| 11-13 | 58 | 15(25.9) | 28 | 4(14.3) | 19(44.1) |
| ≥14 | 53 | 8(15.1) | 34 | 4(11.8) | 12(27.9) |
| **Total** | **164** | **29(17.7)** | **100** | **14(14.0)** | **43(16.3)** |

*P*= 0.23, $\chi^2$ = 4.329, df = 3

**Table 3: Prevalence of urinary schistosomiasis and associated risk factors among the study population.**

| Risk Factors | No. Respondents | No. Positive (%) | $\chi^2$ | *P*-value |
|---|---|---|---|---|
| **Awareness about Schistosomiasis** | | | | |
| Yes | 23 | 3(13.0) | 0.195 | 0.66 |
| No | 241 | 40(16.6) | | |
| **Swimming in River/Pond** | | | | |
| Yes | 60 | 41(68.3) | 154.254 | <0.001 |
| No | 204 | 2(1.0) | | |
| **Washing in River/Pond** | | | | |
| Yes | 82 | 22(26.8) | 9.694 | 0.002 |
| No | 182 | 21(11.5) | | |
| **Sources of Water** | | | | |
| Well | 139 | 19(13.7) | 4.042 | 0.13 |
| Stream | 77 | 18(23.4) | | |
| Borehole/Tap | 48 | 6(12.5) | | |
| **Type of Toilet** | | | | |
| Modern Toilet | 148 | 23(15.5) | 2.601 | 0.46 |
| Pit Toilet | 97 | 19(19.6) | | |
| Open defecation | 19 | 1(5.3) | | |
| **Prophylactic Praziquantel** | | | | |
| Yes | 14 | 1(7.1) | 0.907 | 0.34 |
| No | 250 | 42(16.8) | | |



**Table 4: Relationship between symptoms and prevalence of urinary schistosomiasis among the study population**

| Risk factors | No. Respondents | Positive (%) | $\chi^2$ | *P*-value |
|---|---|---|---|---|
| **Dysuria** | | | | |

| | | | | |
|---|---|---|---|---|
| Yes | 56 | 17(30.4) | 10.319 | 0.001 |
| No | 208 | 26(12.5) | | |
| **Urinary Frequency** | | | | |
| Yes | 66 | 11(16.7) | 0.213 | 0.64 |
| No | 166 | 32(16.2) | | |
| **Terminal Haematuria** | | | | |
| Yes | 78 | 28(35.9) | 31.223 | <0.001 |
| No | 186 | 15(8.1) | | |
| **Lower Abdominal Pain** | | | | |
| Yes | 125 | 22(17.6) | 0.300 | 0.58 |
| No | 139 | 21(15.1) | | |



## 5. DISCUSSION

The prevalence of urinary schistosomiasis was found to be 16.3% among the study population. Comparatively, this prevalence is slightly lower than the prevalence rate of 18.7%, previously reported in the same province among irrigation farmers in 2018 [13]. The difference in the prevalence rate may be due to the difference in the occupations of the study population. While this research was conducted among primary school pupils regardless of their parents' occupations, the previous research was carried out among irrigation farmers which placed them more at risk of urinary schistosomiasis. Reports of higher prevalence from other parts of Nigeria have clearly shown that urinary schistosomiasis is still a serious problem in this part of the world and this may not be unconnected with little or absence of government intervention. A high prevalence of 40.0% and 58.5% were reported in Southwest and Northeast Nigeria respectively [14,15]. These differences in prevalence rates may probably be due to differences in the study population, and the availability of bodies of freshwater infested by the intermediate host, the Bulinus snails. One could have attributed the low prevalence in this study to government interventions by regularly deworming with praziquantel 40mg/kg as advocated by the World Health Organisation (WHO), but such intervention has been non-existent for many years, and while school pupils depend on their parents and occasional Free Medical Outreach in their communities to get dewormed.

Based on the school, pupils recruited from school B had a relatively higher infection rate compared to the other schools. A survey of the town where the school is located revealed many abandoned mining ponds that inhabitants of the area use for washing clothes, irrigation farming, and swimming. This could be a strong reason for the high prevalence in school B, and this underscored the importance of mollusc control in areas surrounded by these mining ponds as part of the preventive measures against urinary schistosomiasis. The schools with low prevalence had good sources of water supply and toilet facilities with no abandoned ponds within the vicinity of the schools. Provision of good and adequate water supply, good toilets, and molluscs control, as well as routine praziquantel administration to vulnerable populations, are critical in tackling parasitic infections including urinary schistosomiasis [16]. Where this is lacking, the prevalence of urinary schistosomiasis will continue to increase due to poverty, poor public health infrastructures, and low literacy levels.

The pattern of urinary schistosomiasis among the participants revealed a typical gender-based preponderance where males were infected more than females. Though not statistically significant, the male participants were responsible for 17.7% while 14.0% of the females were infected. This is possible because males are more involved in outdoor activities such as swimming, fishing, and irrigation farming while females participate less in such activities. This finding is corroborated by many researchers [17,18,19]. Among the male participants, the age group 11-13 years was the most infected while the age group 8-10 years accounted for most of the infections among the female counterparts. This is consistent with research conducted in North-western Nigeria and central Zambia [17,20]. This age group among the males is known for being adventurous and engaging in exploring their environment which couldpredispose them to getting urinary schistosomiasis than the femaleswho are usually more engaged in domestic activities [16]. However, the female age group 11-13 years are known to always help their mothers at the stream in washing clothes and plates thereby predisposing them to urinary schistosomiasis. While this has been supported by previous research [21,22,23], a contrary report from anotherlocation indicated the highest prevalence in the age group 6-10 years old [4]. The variation in theprevalence rates in different age groups from variouscentres may be attributed to natural environmental conditions,water contact patterns of the studied population, and the presence of the intermediate host in locally available water bodies.

The prevalence of urinary schistosomiasis is influenced by key epidemiological determinants such as living near freshwater bodies, irrigation farming, snail species, and indiscriminate defecation [24]. This study analyzed the risk factors among the studied population and discovered that swimming and washing in rivers and ponds had a significant association with urinary schistosomiasis [Table 3]. This implies that open defecation or the use of untreated sewage as fertilizer may still be a practice in the areas. These findings are in concordance with studies conducted in other places [25,26]. The awareness of urinary schistosomiasis was found to be limited among the study population. Only a few responders knew about the infection before the study and 13.0% of them had the infection. This was not statistically significant as well as the sources of water for domestic use and types of toilet facilities. In this context, the type of toilet is not important as long as it fulfils its function of containing human waste and thereby preventing the contamination of water bodies. The majority of the studied population used modern toilets but quite a number still engaged in open defecation which has been reported to be a significant risk factor for urinary schistosomiasis [27]. This habit of open defecation soiled the environment with eggs of parasites which are washed during the rainy season into water bodies used by these communities posing a serious risk for schistosomiasis and other parasitic infections.

This study revealed the common symptoms among the participants as terminal haematuria, dysuria, lower abdominal pain, and urinary frequency. Among these symptoms, terminal haematuria and dysuria had a significant correlation with urinary schistosomiasis. This is in agreement with a report by Bishop and his colleague in Northwestern Nigeria [28]. However, painful urination (dysuria), frequent urination, and abdominal pain were equally significant in their study which were not in this study. Terminal haematuria has always been used as the major symptom to differentiate urinary schistosomiasis from schistosomiasis caused by *Schistosoma haematobium* from schistosomiasis caused by *Schistosoma mansoni* and*Schistosoma japonicum*[29]. Other late complications of urinary schistosomiasis are ulceration, granulomatous inflammation, fibrosis, and as well as bladder cancer [30].

## 6. CONCLUSION

Urinary schistosomiasis is still an endemic disease in Northcentral Nigeria and a recognized cause of terminal haematuria. Efforts must be made through health education and prophylactic praziquantel, as well as control of molluscan species to eradicate and effectively prevent the devastating consequences of this parasitic infection such as bladder cancer.

## LIMITATIONS OF THE STUDY

Despite the DNA extraction of positive cases, sequencing could not be done due to a lack of funds. Also, this study may have been influenced by the inability to examine the freshwater sources for the snail host and quantify the respondents' freshwater contact activities.

## ETHICAL CONSIDERATION

Approval for this study was obtained from the Institutional Ethics Committee of the Plateau State Specialist Hospital and Universal Basic Education Board. A written informed consent was obtained from the schools' authorities, the parents and guardians of the pupils recruited for this research. The pupils were also educated on the health implications of urinary schistosomiasis and their assent was obtained before sampling.



## REFERENCES

1. Viana M, Faust CL, Haydon DT, Webster JP, Lamberton PHL. The effects of subcurative praziquantel treatment on life-history traits and trade-offs in drug-resistant Schistosoma mansoni. Evol Appl. 2018;11(4):488–500.

2. Nwosu D, Anosike J, Nwoke B, Uwaezouke J. Epidemiological Assessment of Vesical Schistosomiasis in Bende Local Government Area of Abia State, Nigeria. J Appl Sci Environ Manag. 2009;10(2):55–60.

3. Utzinger J, N'Goran EK, Caffrey CR, Keiser J. From innovation to application: Social-ecological context, diagnostics, drugs and integrated control of schistosomiasis. Acta Tropica. 2011;120(1):121–37.

4. Umoh NO, Nwamini CF, Inyang NJ, Umo AN, Usanga VU, Nworie A, et al. Prevalence of urinary schistosomiasis amongst primary school children in Ikwo and Ohaukwu Communities of Ebonyi State, Nigeria. Afr J Lab Med. 2020;9(1):812.

5. Kokaliaris C, Garba A, Matuska M, Bronzan RN, Colley DG, Dorkenoo AM, et al. Effect of preventive chemotherapy with praziquantel on schistosomiasis among school-aged children in sub-Saharan Africa: a spatiotemporal modelling study. Lancet Infect Dis. 2022;22(1):136–49.

6. Abdulkareem BO, Habeeb KO, Kazeem A, Adam AO, Samuel UU. Urogenital Schistosomiasis among Schoolchildren and the Associated Risk Factors in Selected Rural Communities of Kwara State, Nigeria. J Trop Med. 2018;2018:1–6.

7. Nkegbe E. Sex prevalence of schistosomiasis among school children in five communities in the lower river volta basin of South Eastern Ghana. African J Biomed Res. 2010;13(1):87–8.

8. Karunamoorthi K, Almalki M, Ghailan K. Schistosomiasis: A neglected tropical disease of poverty: A call for intersectoral mitigation strategies for better health. J Heal Res Rev. 2018;5(1):1.

9. Van Der Werf MJ, De Vlas SJ, Brooker S, Looman CWN, Nagelkerke NJD, Habbema JDF, et al. Quantification of clinical morbidity associated with schistosome infection in sub-Saharan Africa. In: Acta Tropica. 2003;86(2-3):125–39.

10. Xu J, Li SZ, Zhang LJ, Bergquist R, Dang H, Wang Q, et al. Surveillance-based evidence: Elimination of schistosomiasis as a public health problem in the Peoples' Republic of China. Infect Dis Poverty. 2020;9(1).

11. Deribew K, Yewhalaw D, Erko B, Mekonnen Z. Urogenital schistosomiasis prevalence and diagnostic performance of urine filtration and urinalysis reagent strip in schoolchildren, Ethiopia. PLoS One. 2022;17(7):e0271569.

12. Wiegand RE, Secor WE, Fleming FM, French MD, King CH, Deol AK, et al. Associations between infection intensity categories and morbidity prevalence in school-age children are much stronger for Schistosoma haematobium than for S. mansoni. PLoS Negl Trop Dis. 2021;15(5):e0009444.

13. Damen J, Kopkuk E, Lugos M. Prevalence of Urinary Schistosomiasis Among Irrigation Farmers in North Central Nigeria. J Med Heal Sci. 2018;7(3):1–47.

14. Houmsou RS, Panda SM, Elkanah SO, Garba LC, Wama BE, Amuta EU, et al. Cross-sectional study and spatial distribution of schistosomiasis among children in Northeastern Nigeria. Asian Pac J Trop Biomed. 2016;6(6):477–84.

15. Ojo JA, Adedokun SA, Akindele AA, Olorunfemi AB, Otutu OA, Ojurongbe TA, et al. Prevalence of urogenital and intestinal schistosomiasis among school children in south-west Nigeria. PLoS Negl Trop Dis. 2021;15(7):e0009628.

16. Dahal Samuel Abednego , Esther Onyimowo Francis, Joy Eguweye Francis FIW. Soil-transmitted Helminths and Associated Risk Factors among Elementary School Pupils in Dadin Kowa, Jos. Niger Med. 2019;60(4):181–185.

17. Umar S, Shinkafi SH, Hudu SA, Neela V, Suresh K, Nordin SA, et al. Prevalence and molecular characterisation of Schistosoma haematobium among primary school children in Kebbi State, Nigeria. Ann Parasitol. 2017;63(2):133–9.

18. Omenesa HO, Bishop HG, Raji HM. Prevalence Of Urinary Schistosomiasis Among Pupils Attending Primary Schools In Bomo Village, Zaria-Nigeria. Int J Res Eng Sci. 2015;3(5):14–19.

19. Muhammad IA, Abdullahi K, Bala AY, Shinkafi SA. Prevalence of urinary schistosomiasis among

primary school pupils in Wamakko Local Government, Sokoto State, Nigeria. J Basic Appl Zool. 2019;80(22).

20. Shehata M, Chama M, Funjika E. Prevalence and intensity of Schistosoma haematobium infection among schoolchildren in central Zambia before and after mass treatment with a single dose of praziquantel. Trop Parasitol. 2018;8(1):12–7.

21. Senghor B, Diallo A, Sylla SN, Doucouré S, Ndiath MO, Gaayeb L, et al. Prevalence and intensity of urinary schistosomiasis among school children in the district of Niakhar, region of Fatick, Senegal. Parasites and Vectors. 2014;7(1).

22. Charles E. Urinary Schistosomiasis among school age children in some rural communities of Abia State, South Eastern Nigeria. Anim Res Int. 2014;11(2):1953–1957.

23. Deribe K, Eldaw A, Hadziabduli S, Kailie E, Omer MD, Mohammed AE, et al. High prevalence of urinary schistosomiasis in two communities in South Darfur: Implication for interventions. Parasites and Vectors. 2011;7(4):14.

24. Steinmann P, Keiser J, Bos R, Tanner M, Utzinger J. Schistosomiasis and water resources development: systematic review, meta-analysis, and estimates of people at risk. Lancet Infectious Diseases. 2006;6(7):411–425.

25. Imran E. Prevalence and Intensity of Schistosomiasis in Adjacent Human Communities along the River Kochi, West Nile Region of Uganda. Int J Trop Dis Heal. 2014;4(6):729–39.

26. Okoli CG, Anosike JC, Iwuala MOE. Prevalence and Distribution of Urinary Schistosomiasis in Ohaji/Egbema Local Government Area of Imo State, Nigeria. The Journal of American Science. 2006;2(4):45–48.

27. Coulibaly JT, N'gbesso YK, N'guessan NA, Winkler MS, Utzinger J, N'goran EK. Epidemiology of schistosomiasis in two high-risk communities of south cote d'ivoire with particular emphasis on pre-school-aged children. Am J Trop Med Hyg. 2013;89(1):32–41.

28. Bishop HG. Risk factors, symptoms and effects of urinary schistosomiasis on anthropometric indices of school children in Zaria, Kaduna state, Nigeria. Open Access J Sci. 2018;2(1):61–65.

29. Lin YY, Lin VCH, Chang IW. Urinary schistosomiasis: Schistosoma haematobium infection diagnosed by histopathology. Indian Journal of Pathology and Microbiology. 2017;60(4):614–615.

30. Efared B, Bako ABA, Idrissa B, Alhousseini D, Boureima HS, Sodé HC, et al. Urinary bladder Schistosoma haematobium-related squamous cell carcinoma: a report of two fatal cases and literature review. Trop Dis Travel Med Vaccines. 2022;8(1):3.