Impact of Water Sources on Schistosomiasis Transmission and Urine Indicators

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Abstract

BACKGROUND

Schistosomiasis is a significant debilitating disease caused by Schistosoma species. Infection is acquired when people come into contact with fresh water infested with the larval forms (cercariae) of parasitic blood flukes, known as schistosomes. The study aimed to assess the impact of water sources on schistosomiasis transmission and potential urinary markers for diagnosis.

METHODOLOGY

In this cross-sectional study, a total of 230 pupils were examined. Stool and urine samples were collected from each of them. Stool samples were analysed using the Formal-ether concentration method, and urine samples using the centrifugation sedimentation method and reagent strip.

RESULTS

This study showed that out of 230 pupils examined, 7(3.0%) were infected with S. mansoni, and 4(1.7%) were infected with S. haematobium. Prevalence of Schistosomiasis according to a source of water contact; revealed a significant difference in infection level based on the source of drinking water at (P<0.05). Those whose source was Dam/River had the highest prevalence, 4(25.0%), followed by stream water 4(10.0%), and the least was well water 2(3.30%). The ability of microhaematuria and proteinuria to accurately identify all those with the disease (sensitivity) was 25.0% and 75.0%, respectively. In comparison, the ability to sort out all those without the disease (specificity) was 97.35% and 96.46%, respectively.

CONCLUSION

The presence of Schistosomiasis among school children is linked to the water sources. Hence, water treatment intervention must reduce the risk of Schistosomiasis among pupils in Kisayhip, Bassa Local Government Area, Plateau State.

***Keywords**: Schistosoma Spp., Schistosomiasis, Prevalence, Cercariae, Infection*

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Introduction

Schistosomiasis is a parasitic infection and the third leading tropical disease, according to a World Health Organization (WHO) report. More than 200 million people, 91.4% of whom live in Africa, are infected with Schistosomiasis [1], and an estimated 700 million people are at risk of infection in 76 countries where the disease is considered endemic, as their agricultural work,

domestic chores, and recreational activities expose them to infested water [1]. The death estimates due to Schistosomiasis need to be re-assessed, as it varies between 24 067 and 200,000 globally per year. In 2000, WHO estimated the annual death rate at 200,000 globally [2]. This should have decreased considerably because of the impact of a scale-up in large-scale preventive chemotherapy campaigns over the past decades [1]. Schistosomiasis is sometimes referred to as bilharzia or snail fever. Theodore Bilharz, a German surgeon in Cairo, discovered it first and identified the etiological agent *Schistosoma haematobium* in 1851 [3]. *Schistosoma mansoni* and *Schistosoma haematobium* are the most widespread species. In Africa, they are often together in the same area, with many carrying both specie [2]. Testing the urine with reagent strips for microhaematuria is a simple and indirect diagnostic technique that could estimate the prevalence of urinary Schistosomiasis in school children of endemic communities. In early 2012, the WHO issued an ambitious goal to control Schistosomiasis globally by 2020 and put forward a roadmap to achieve this [4]. Prevalence is high in tropical and sub-tropical areas and poor communities without potable water and adequate sanitation. Urogenital Schistosomiasis is caused by *Schistosoma haematobium* and intestinal Schistosomiasis by any organism *S. guineensis*, *S. intercalatum, S. mansoni*, *S. japonicum*, and *S. mekongi*. Other studies have studied the prevalence of Schistosomiasis in various areas and States in Nigeria. However, there are limited studies on the impact of water sources on schistosomiasis prevalence. Therefore, this study focused on assessing the impact of water sources on schistosomiasis transmission and potential urinary markers for diagnosis.

Material and Methods

Study design

The cross-sectional study was conducted between March 2018 and May 2019. The study consisted of 230 primary school pupils at Bassa Local Government Area in Plateau State. Five primary schools designated A, B, C, D and E were selected to recruit the pupils. "A school" had 58 pupils who participated in the study, "B school' had 50 pupils who participated in the study, 'C school" had 30 pupils who participated in the study, 'D school' had 50 pupils who participated in the study and 'E school' had 50 pupils who participated in the study. Stool and urine samples were collected and microscopically studied for the presence of *Schistosome*, and urinalysis was further performed for haematuria and proteinuria.

Study location

This study was conducted at five primary schools located at Kisayhip, Bassa Local Government Area, Plateau State, Nigeria. The area has an annual rainfall ranging from 500mm to 1300mm. In Bassa, agriculture is a significant occupation amongst many of the population. Activities like swimming, washing clothes in the stream, and irrigational agriculture, take place in this community.

Ethical clearance and consent

Application for ethical approval was submitted to the Ethics Committee, Plateau Specialist Hospital, Jos. The application was approved, and ethical clearance was obtained from the committee with Document registration number NHREC/05/01/2010b.

Eligibility Criteria

Inclusion criteria

Children between the age of 5 and to 14years were included in the study provided they provided adequate information in the well-structured questionnaire, and their parents or guardians provided consent for participation on their behalf.

Exclusion criteria

Pupils undergoing anti-parasitic treatment were excluded and those not duly

registered with the school selected in this study. Also, pupils who did not want to continue the study even after consent were excluded from the study participation.

Sample size determination

The sample was determined from the statistical equation below:

Sample size (N) = $(Zt\text{-}\alpha/2)^2P(1\text{-}P)/d2$

Where:

N= sample size

Zt-α/2= confidence interval (95%=1.96)

P= Expected proportion in population based on previous studies in Kano State (17.8%=0.178) Salwa *et al*. [3]

d = Absolute error or precision (5%=0.05)

Thus:

$N= 1.96^2 \times 0.178(1\text{-}0.178)/0.05^2$

N= 0.562/0.0025

N=225

The same size was approximated to be 230.

Sampling method

Participating schools within Kisayhip were selected randomly, and pupils who met the inclusion criteria were selected using a random technique that employed a numbering system where pupils were made to pick randomly. All those who picked "1" were selected, while those who picked "0" were not selected [5,6].

Sample collection

Twice a week, between 10 am and 2 pm, urine and stool samples were collected from pupils using a sterile universal container. The samples collected were preserved in an ice pack transport medium and transported to the laboratory for analysis.

Laboratory analysis

Parasitological examination of stool and urine samples for eggs (ova) is the primary method of diagnosis for suspected *Schistosome* infections. This included macroscopic and microscopic examinations.

Examination of Urine Specimen

Macroscopic examination

Each urine sample was observed for the colour appearance of amber, reddish, and the presence or absence of blood.

Microscopy (Centrifugation technique)

A simple centrifugation sedimentation technique for microscopic examination was used. The method described by Dazo was employed [7]. Ten (10) ml of each well-mixed urine sample were transferred into a centrifuge tube, labelled and centrifuged at 10 000 rpm for 5 minutes. The supernatant was discarded into a disinfectant jar, and a drop of well-mixed sediment was placed on a clean grease-free slide with the aid of a Pasteur pipette which was covered gently with cover-slip avoiding air bubbles and overflooding. The preparation was then examined using x10 and x 40 objectives for the terminally spined ova of *Schistosoma haematobium*. The results were recorded appropriately.

Detection of Microhaematuria and Proteinuria by Urinalysis

Urinalysis was done with a reagent strip (ComboStik 10) manufactured by DFI Company Ltd. The manufacturer's test instructions were strictly followed to detect microhaematuria and proteinuria in the urine sample. The strip was gently removed from its container, and a directional arrow was marked on it. The strip was dipped into the urine sample and allowed to get wet. The strip was read by comparing with the standard on the back of the container within 2 minutes and reported [8].

Examination of stool for schistosome eggs

To detect the eggs of *S. mansoni*, qualitative and quantitative analyses were done on the stool samples. The stool samples were first homogenised with an applicator for direct qualitative examination. A light emulsion of the

homogenised stool was made on the slide with normal saline using an applicator and covered gently with a cover slip. This was subsequently examined microscopically using x10 and x40 objectives, respectively. As described by [9], the formal-ether concentration technique was used for the quantitative method. One gram of sample was placed in a test tube, and drops of normal saline were added and emulsified thoroughly. Seven ml of 10% normal saline was added and mixed thoroughly, and 3 ml of ether was added and covered with a rubber band. |It was then shaken vigorously and centrifuged at 3000 rpm for 3min. The supernatant was discarded, and the deposit was examined using x10 and x40 objectives.

Statistical analysis

Data were analysed using SSPS 23.0 for chi-square where $p<0.05$ is considered significant. The sensitivity and specificity of haematuria and proteinuria were calculated using a two-by-two contingency table to determine their diagnostic values in urinary Schistosomiasis.

Results

Table 1 shows the prevalence of Schistosomiasis according to species. The results show no significant difference between *S. haematobium* and *S. mansoni*, with a prevalence of 1.70% and 3.0%, respectively. Table 2 shows the prevalence of Schistosomiasis according to the source of water contact.

The results revealed a significant difference in infection level based on the source of water contact at ($P<0.05$). Those whose source was dam/river had the highest prevalence, 5(25.0%), followed by stream water, 4(10.00%), and the least was well water, 2(3.30%).

Table 1:
Prevalence of Schistosomiasis According to Schistosoma Species

Primary School	No. Examined	No. Infected *S.haematobium(%)*	*S.mansoni (%)*
A	58	2(4.0)	1 (2.0)
B	50	-	2(4.0)
C	30	-	-
D	50	-	2(4.0)
E	50	2(4.0)	2(4.0)
TOTAL	230	4(1.7)	7(3.0)

Key: $\chi = 5.292$; df=4; P= 0.259; Result is significant when ($P<0.05$)

Table 2:
Prevalence of Schistosomiasis According to Source of Water Contact

Source	Number Examined	No. Infected (%)
Borehole	110	-
Well	60	2(3,30)
Dam/River	20	5(25.00)
Stream	40	4(10.00)
TOTAL	230	11(4.80)
$\chi^2=26,144$	df=3	P=0.001

The result is significant at ($P<0.05$)

No prevalence was observed in those who utilised boreholes as drinking water and water contact sources.

Table 3.0 shows the prevalence of *Schistosoma haematobium* and microhaematuria in the study area. The result revealed a significant difference in the level of *Schistosoma haematobium* infection in students with microhaematuria at (P<0.05). Those who were positive for microhaematuria had the highest prevalence 2(25.0%), while those who were negative for microhematuria had the least infection 2(0.9). the overall prevalence was 4(1.7%). The sensitivity and specificity of haematuria were calculated using two by two contingency table to determine their diagnostic value in urinary Schistosomiasis. Sensitivity was calculated. Thus, Sensitivity = a/a+c X $\frac{100}{1}$, specificity =$\frac{d}{d+b}$ x $\frac{100}{1}$. a= true positive, b= false positive, c= false negative, d=true negative.

Table 4.0 shows the prevalence of *Schistosoma haematobium* and proteinuria in the study area. The result revealed a significant difference in the level of *Schistosoma haematobium* infection in students with proteinuria at (P<0.05). Those who were positive for proteinuria had the highest prevalence, 3(27.0%), while those who were negative for proteinuria had the least infection, 1(0.5), and the overall prevalence was 4(1.7%). The sensitivity and specificity of proteinuria were calculated using two by two contingency table to determine their diagnostic value in urinary Schistosomiasis. Sentivity = a/a+c X $\frac{100}{1}$, Specficity =$\frac{d}{d+b}$ x $\frac{100}{1}$. a= true positive, b= false positive, c= false negative, d=true negative.

Table 3:
Sensitivity and Specificity of Microhaematuria in the Diagnosis of Schistosomiasis

Screening Test	**Microheamaturia**	**Number infected with *S.heamatobium*%**	**Number uninfected with *S.heamatobium* %**
Positive	8	2(25.0)[a]	6(75.0)[b]
Negative	222	2(0.9)[c]	220(99.1)[d]
TOTAL	230	4(1.7)	226(98.3)
χ^2=26.242		df=1	P=0.001

The result is significant at (P<0.05)

Table 4:
Sensitivity and Specificity of Proteinuria in the Diagnosis of Schistosomiasis

Screening Test	**Proteinuria**	**Number infected with *S.heamtobium*%**	**Number uninfected with *S. haematobium* %**
Positive	11	3(27.3)[a]	8(72.7)[b]
Negative	219	1(0.5)[c]	218(99.5)[d]
TOTAL	230	4(1.7)	226(98.3)
χ^2=44.075		df=1	P=0.001

The result is significant at (P<0.05)

Discussion

Considering the sources of water contact in the study area, the highest infection rate was among those pupils who have contact with Dams and Rivers; the percentage infection rate was found to be (25.0%). This correlates with a study by Kiran and colleagues, who reported a prevalence of 75% among those whose source of water contact is the river in Sokoto state [10]. This is because rivers and dams provide grasses and shrubs, which serve as a suitable substrate for snail vectors, hence encouraging a rapid increase in the population of snails with a subsequent increase in cercarial load. Prevalence of urinary schistosomiasis infection based on water contact behaviour has been reported by various authors [10] previously; their findings are in line with the present study, which indicated a high prevalence rate of the infection among those whose source of water contact is dam/river which is used for activities like farming/irrigation, swimming and fishing. This may be due to the prolonged exposure of the body to infected water, thus giving more chances to cercarial penetration through the skin; in the act of swimming and fishing, the whole body remains in contact with water, providing more surface area for penetration of larval stages through the skin.

This could be attributed to the preference shown by snail hosts for slow-flowing rivers or stagnant bodies of water. Because these snails harbour schistosome parasites and contribute to a high infection rate among the people coming in contact with such water bodies [11,12] and simple control measures like the provision of safe drinking water from the borehole and treated, water has been recommended for the control of Schistosomiasis [13]. Also, public health officers have asked those close to the water reservoirs to be monitored and treated [14].

The ability of microhaematuria and proteinuria to accurately identify all those with the disease (sensitivity) was 25.0% and 75.0%, respectively. At the same time, the ability to sort out all those without the disease (specificity) was 97.35% and 96.46%, respectively (Tables 3 and 4). The use of urine reagent strips has been proposed as an indirect method in identifying *S. haematobium*-infected children, hence a valuable tool to rapidly map the prevalence of urinary Schistosomiasis in endemic areas [15].

The evaluation of microhaematuria as an indicator for urinary Schistosomiasis shows a sensitivity of 25.0% and specificity of 97.35%. This is low when compared to the findings of Okwori and his team. They reported a sensitivity of 68.3% and specificity of 83.2% among school children of two endemic areas in Southwestern Nigeria [16], and the sensitivity of microhaematuria reported by Houmsou and his co-workers in 2011 reported a sensitivity of 64.8% but a specificity of 89.6% [17]. The low prevalence obtained in this study could be attributed to the low sensitivity and specificity of microhaematuria in this study. However, variation in sensitivity and specificity of microhaematuria during *Schistosoma haematobium* infection has been reported in several studies conducted in different African settings. They have been reported to vary from 41.0% to 93.0% and from 67.0 % to 99.0 % for sensitivity and specificity, respectively [18]. The sensitivity and specificity of proteinuria in this study (75.0% and 96.46%, respectively) differ from Houmsou's study, which reported 95.7% and 67.2%, respectively [16].

Study limitations

The peculiar challenge confronted in this study was parents' refusal to consent for their children. This challenge lingered on the expected period of completion of sample collection.

Conclusion

Rivers and dams have been demonstrated as the significant source of schistosomiasis

transmission among pupils in Kisayhip of Bassa Local Government Area in Plateau State, Nigeria.

Recommendation

The provision of treated borehole water will go a long way to reduce the rate of transmission and re-infection. Screening urine using commercially available urine strips would provide the first-line diagnosis of Schistosomiasis among pupils in Kisayhip.

References

1. **World Health Organisation** (2016). Schistosomiasis and soil-transmitted helminthiasis: number of people treated in 2016. *Weekly epidemiological records*, 49, 749–760.
2. **Chistulo, L., Loverde, P., and Engels D.** (2004). Disease Watch: Schistosomiasis. *Nature Reviews Microbiology*, 2, 1-7.
3. **Nawal, M.** (2010). Schistosomiasis: Health Effects on Women. *Reviews in Obstetrics & Gynecology*, pp. 3, 28–32.
4. **World Health Organisation** (2012). Schistosomiasis Progress Report. 2001-2011 and Strategic Plan 2012-2020, Geneva, *WHO*. pp 78
5. **Fyneface, C. A., Joel, B. K. and Felix, E. K**. (2020). Assessment of creatinine levels in blood and saliva of haemodialysed subjects. *International Journal of Advances in Nephrology Research*, 3(1), 21-25.
6. **Fyneface, C. A., Onengiyeofori, I. and Davies, T.** (2018). Evaluation of Saliva for Monitoring Renal Function in Haemodialysis Patients at University of Port Harcourt Teaching Hospital. *Asian Journal of Biochemistry, Genetics and Molecular Biology*, 1(2), 1-6.
7. **Dazo, B. C** (1974). Two new field techniques for detection and counting of Schistosoma haematobium eggs in urine samples with an evaluation of both methods. *Bulletin of the World Health Organization*, pp. 51, 399-408
8. **Awosolu, O. B., Adesina F. P., Eke, O.S., Akimnifesi, O. J.** (2019). Efficacy of chemical reagent strip in the diagnosis of nursing schistosomiasis in Ikota, Ifedore local government area, Ondo State, Nigeria. *Journal of Bacteriology and Parasitology*, 10(2), 354
9. **Cheesbrough, M.** (2002). District Laboratory Practice in Tropical Countries. Part 2 Cambridge University Press: *Cambridge, UK*.105-112.
10. **Kiran, S., Dalhatu, M. and Jitendra, S.** (2016). Current status of schistosomiasis in Sokoto, Nigeria. *Journal of Parasitic Epidemiology and Control*, 1(3), 239-244.
11. **Jack, E. T. G., David, C., Wendy, E. H., Jurg, U., Matthew, C. F. & Michael, R. T.** (2015). The role of water, sanitation and hygiene in reducing Schistosomiasis: a review. *Parasites Vectors*, pp. 8, 156.
12. **O. C. Ezeanyagu , E. O. Onosakponome , O. R. Ejinaka , C. U. Nyenke and M. U. Obeta** (2022) The Prevalence Study of Urinary Schistosomiasis among the Primary School Pupils in Kisayhip, Bassa Local Government Area, Plateau State-Nigeria *International Journal of Tropical Disease & Health* 43(14): 31-36 .
13. **Ejinaka, O.R., Obeta, M.U., Agbalaka, P.I. & Ajik, H.** (2019). Current review of diagnosis and control of urogenital schistosomiasis. The Diagnostics, 3(1): 40-57. www.thediagnostics.org
14. **Ejinaka, O., Agbalaka, P., Obeta, U., Ezeanyagu, O., Imoh, I., John P., and Dabo H**. (2022). Prevalence of Urinary Schistosomiasis among Pupils in Pilot Primary School Jos North Local Government of Plateau State, Nigeria. *South Asian Research Journal Nursing and Health Care*, 4(2): 15-20
15. **Ishaku, A., Ashefo, D., Habibu, T., Mary, T. & Godwin, A.A.** (2010). Microhematuria and Proteinuria as Measured by Urine Reagent Strips in Estimating Intensity and Prevalence of S. haematobium infection in

Nigeria. *American Journal of Medicine and Medical Sciences*, 2(6), 144–148.

16. **Okwori, A.E.J., Sidi, M., Ngwai, Y.B., Obieke, S.O., Makut, M.D., Chollom, S.C., Okeke, I.O. and Adikwu, T.I.** (2014). Prevalence of Schistosomiasis among Primary School Children in Gadabuke District, Toto LGA, North Central Nigeria. *British Microbiology Research Journal*, 4(3), 255-261.
17. **Houmsou R. S., Kela, S.L. and Suleiman, M. M.** (2011). Performance of microhaematuria and proteinuria as measured by urine reagent strips in estimating intensity and prevalence of Schistosoma haematobium infection in Nigeria. *Asian Pac J Trop Med*, 4(12), 997-1000
18. **Brooker, B. E.** (1972). The sense organs of trematodes miracidia. In E. U. Canning and C. A Wright (Eds), Behavioural Aspects of Parasite Transmission. *Linnean Society of London: Academic Press*. Pp 171 – 180.