Science World Journal Vol. 20(No 4) 2025 https://dx.doi.org/10.4314/swj.v20i4.33
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Full Length Research Article

COMPARATIVE OCCURRENCE OF URINARY SCHISTOSOMIASIS AND ITS DIAGNOSTIC ANALYTES AMONG CHILDREN IN SECONDARY AND PRIMARY SCHOOLS IN UNGWAN KUGU, ZARIA

*[1]Henry Gabriel BISHOP; [2]Danladi Austine MARKUS; [1]Augustine Otogor ODEY; [1]Aliyu Majeru ABDULLAHI; [1]Eleyi Rosemary AMEH; [3]Mercy Onyiyioza OTORI; [4]Samuel JACOB, [1]Blessing Njideka EZEA; [5]Jemimah BARWA; [6]Bamidele Oloyede GABRIEL, [1]Ruth Iye AKOH

[1]Department of Microbiology, Faculty of Life Sciences, Ahmadu Bello University, Zaria, Kaduna State, Nigeria
[2]Department of Food Science Technology, School of Science, Plateau State Polytechnic, Barkin Ladi, Plateau State, Nigeria
[3]Biofertilizer Unit, National Research Institute for Chemical Technology, Zaria, Kaduna State, Nigeria
[4]Laser Engineering and Resources Consultants Limited, Port Harcourt, River State, Nigeria
[5]Department of Microbiology, Faculty of Science, University of Abuja, FCT, Nigeria
[6]Department of Environmental Management and Pollution, Faculty of Environmental Management, Nigerian Maritime University, Okerenkoko, Delta State, Nigeria

*Corresponding Author Email Address: gabrielhenrybishop@gmail.com Phone: +2347064608775

ABSTRACT
Urinary schistosomiasis is persistent in Nigeria. This study compared the occurrence of urinary schistosomiasis and its urinary analytes among secondary and primary school children in Ungwan Kugu, Zaria. Randomly selected school children (comprised of 100 each) from secondary and primary schools were included in the study. Each urine sample (10ml) provided by the participants was subjected to urinalysis and centrifugation at 3000rpm for 5 minutes. The sediment was microscopically examined for eggs of *Schistosoma haematobium*. Occurrence of urinary schistosomiasis was 15.0% and 11.0% among children in secondary and primary schools respectively. Secondary school children between 18-20 years old had higher occurrence of the infection (18.6%); while those between 11-14 years old were more infected in primary school (14.8%). Males were significantly more infected than females in both groups ($P<0.05$). Significant risk factors common to both groups included swimming, fishing and washing in streams ($P<0.05$). Irrigation farming was a significant risk factor among children in secondary school ($P<0.05$); while lack of awareness and sourcing of water from streams were significant ($P<0.05$) among those in primary school. Frequent urination, abdominal pain and terminal haematuria were significant symptoms of the disease in both groups ($P<0.05$). Painful urination ($P<0.05$) was significant only among those in secondary school. Significant urinary analytes of urinary schistosomiasis in both groups included leukocytes, proteins and microhaematuria. Urine specific gravity above 1.015 was associated with the infection among primary school children. These findings underscore the need for increased awareness and broadened administration of Praziquantel to children in affected areas.

Keywords: Urinary schistosomiasis, Analytes, Children, Primary, Secondary, Zaria.

INTRODUCTION

Urinary schistosomiasis (also called urogenital schistosomiasis) is a persistent disease in Nigeria, majorly affecting children in rural areas. Uncontrolled juvenile activities in unsafe water bodies and lack of awareness promote persistence of the disease. In many rural communities, both children and adults engage in irrigation, bathing, fishing, washing or fetching of water from stagnant water bodies or slow-flowing streams. These water sources are predisposed to infestation with schistosome cercrcarie (Bishop, 2017; WHO, 2023; Bishop, 2024). Indiscriminate water-contact activities in unsafe water sources bring children in close proximity to the cercariae that penetrate their exposed skin to ensue infections (Santos *et al.*, 2021).

Children are easily attracted by water and tend to play often in any water body accessible to them. Hence, communities that lack access to safe water or have poor level of sanitation are more prone to schistosomiasis (WHO, 2023; Bishop, 2024). Therefore, it is imperative to ensure that the health of school children is protected at all times. Despite wide-spread occurrence of schistosomiasis in tropical and subtropical areas, a substantial proportion of human population across affected areas is unaware of the disease. This affects progress made in combating the disease; making the vision of its elimination becoming unsure (Markus and Bishop, 2024).

The economic and health implications of schistosomiasis are considerable, although the disease disables more than it kills. Among infected children, schistosomiasis may cause anaemia, stunting and reduced ability to learn, although these effects are usually reversible following treatment (Weerakoon *et al.,* 2015; Bishop and Akoh, 2018), but delayed treatment causes prolonged entrapment of *Schistosoma haematobium* eggs in parenchymal tissues with consequent inflammation, fibrosis, granulomata, sandy patches and bladder cancer (Santos *et al.*, 2021; Oyibo *et al.*, 2023; WHO, 2023) Chronic schistosomiasis may affect people's ability to work and in some cases, can result in death. The number of deaths due to schistosomiasis is difficult to estimate because of hidden pathologies such as liver and kidney failure, bladder cancer and ectopic pregnancies due to female schistosomiasis (Weerakoon *et al.,* 2015; WHO, 2023).

In rural and other resource-limited areas, microscopy and other advanced methods like polymerase chain reaction (PCR) for diagnosis of urinary schistosomiasis may not be available (Bishop, 2024). Hence, urinalysis can useful for rapid, cheaper and non-invasive method for evaluating urinary analytes that can serve as biomarkers of urinary schistosomiasis (Vere *et al.*, 2025). This study was aimed at determining the comparative occurrence of

urinary schistosomiasis among secondary and primary school children, as well as evaluate the urinary analytes as possible biomarkers of the infection.

MATERIALS AND METHODS

Study Area

The study was conducted in Ungwan Kugu, a rural community in Zaria. The area has public secondary and primary schools. Inhabitants of this area majorly engage in farming. They often employ irrigation system for all-year-round cultivation of vegetables like onions, tomatoes, peppers, cucumber, carrots; as well as potatoes and sugarcane.

Study Design and Population

It was a cross-sectional descriptive study that included randomly selected male and female children from public secondary and primary schools within the area. Awareness about schistosomiasis was created by directly talking to the children during morning assembly before the random selection of 100 consented participants from each category. Permission for this study was obtained from the respective school managements. All the selected children willingly gave verbal consents before their enrolment into the study. The secondary school students were between 15-20 years old, while primary school pupils were between 7-14 years old.

Administration of Structured Questionnaire

A designed questionnaire for this study was administered to gather information from the participants on their demography, exposure to certain risk factors, and signs/symptoms they experienced. Further explanation or interpretation in the local language (Hausa) was provided when requested by some participants through the help of their teachers and members of the research team.

Collection of Urine Samples

Each of the participants was provided with a sterile, wide-mouth, screw-capped, plastic sampling bottle for collection of urine samples. They were guided on how to provide 10mL urine samples during break time (10:00-10:30am). Each sample was labelled with a correspondingly-filled questionnaire. The samples were shielded from sunlight and immediately conveyed in opague containers with ice packs to Parasitology and Bacteriology Laboratory at the Department of Microbiology, Ahmadu Bello University, Zaria. The time interval between collection of the samples and laboratory analysis was about 30 minutes.

Laboratory Analyses

Detection of Urinary Analytes

Eleven analytes were detected by urinalysis using urine reagent test strips (SG11100-Uric 11V, Guilin Zhonghui Technology Co., Ltd, China). For each sample, a separate Uric 11V strip was directly dipped until all the reagent pads were immersed and removed immediately. Excess urine was removed by gently running back of the strip against the rim of the sample container. The strip was held in horizontal position to prevent cross contamination of chemical reactions in adjacent reagent pads. The results were read within stipulated time by comparing the colour changes on reagent pad for each analyte to its corresponding colour-coded chart on the manual attached to the strip vial. Specific gravity, ketone, bilirubin, glucose and ascorbic acid were detected after 45 seconds each. Nitrite, urobilinogen, protein and pH were detected after 60 seconds each. Leukocytes were detected after 2 minutes. Record for the eleven analytes was obtained for each sample screened (Bishop, 2024).

Detection of *Schistosoma haematobium*

Each 10mL sample was gently agitated before loosening the screw-cap, then transferred into labelled centrifuge tubes. Centrifugation was done at 3000 revolutions per minute (rpm) for 5 minutes, then the supernatant was discarded. The sediment retained at the bottom of the centrifuge tube was collected using a Pasteur pipette. Wet mount of the urine sediment was made. A coverslip was applied over the wet mount, then it was examined for characteristic ova of *Schistosoma haematobium* (with terminal spines) using 10× and 40× objectives of compound light microscope. Colour atlas of Parasitology was used as guide in identifying the ova of *Schistosoma haematobium* (Cheesbrough, 2009; Bishop and Akoh, 2018).

Statistical Analysis

Chi Square (χ^2) and Odd Ratio (OR) analyses using IBM SPSS version 23 were applied to determine any significant association in the distribution of urinary schistosomiasis based on school level of the study subjects, and their demographic data. Also, the χ^2 and OR were used to determine if there were any significant associations between the urinary analytes and urinary schistosomiasis among the subjects, as well as the risk factors and symptoms. The results were simplified and presented in a chart and tables.

RESULTS

Occurrence of urinary schistosomiasis among the secondary school children was 15.0%, while children in primary school had 11.0% infection (Figure 1).

Secondary school children between 18-20 years old had higher occurrence of urinary schistosomiasis (18.6%) than those between 15-17 years old who recorded 9.8%. In the primary school, children between 11-14 years old had higher occurrence of 14.8%, while those between 7-10 years old had 6.5% of the infection. Age distribution of urinary schistosomiasis in both secondary and primary schools were not statistically significant (P>0.05), however, the younger age group of 15-17 years old were more at risk of the infection (OR>1). Males were significantly more infected than females in both groups (P<0.05) as shown in Table 1.

Significant risk factors common to both groups (Table 2) included swimming, fishing and washing in streams (P<0.05). Irrigation farming was a significant risk factor among children in secondary school (P<0.05); while lack of awareness and sourcing of water from streams were significant (P<0.05) among those in primary school.

Signs/symptoms of urinary schistosomiasis among the school children are presented in Table 3. Frequent urination, abdominal pain and terminal haematuria were significant symptoms of the disease in both groups (P<0.05) Painful urination (P<0.05) was significant only among those in secondary school.

Significant urinary analytes of urinary schistosomiasis common to both groups included leukocytes, proteins and microhaematuria. Urine specific gravity >1.015 was a significant analyte of the infection among primary school children (Table 4).

Science World Journal Vol. 20(No 4) 2025 https://dx.doi.org/10.4314/swj.v20i4.33
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

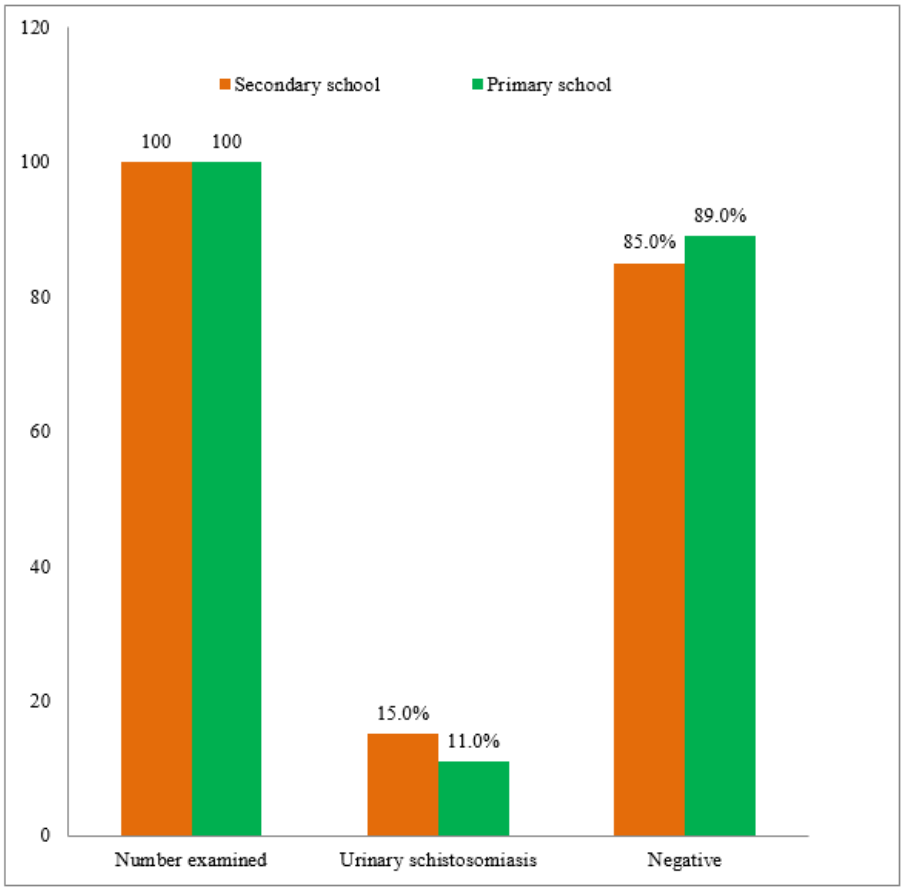

Figure 1: Comparative Occurrence of Urinary Schistosomiasis among Secondary and Primary School Children in Ungwan Kugu, Zaria

Table 1: Comparative Age and Gender Distributions of Urinary Schistosomiasis among Secondary and Primary Children in Ungwan Kugu, Zaria

Secondary School	n	Number positive (%)	*P-value	Odds Ratio (OR)	Primary School	n	Number positive (%)	*P-value	Odds Ratio (OR)
Age (Years)					**Age (Years)**				
15-17	41	4(9.8)	0.221	2.120	7-10	46	3(6.5)	0.187	2.493
18-20	59	11(18.6)		0.472	11-14	54	8(14.8)		0.401
Gender					**Gender**				
Female	45	2(4.4)	0.007	6.655	Female	42	1(2.4)	0.019	8.524
Male	55	13(23.6)		0.150	Male	58	10(17.2)		0.117

n = Number examined; *Chi Square analysis (χ^2)

Table 2: Risk Factors of Urinary Schistosomiasis among Secondary and Primary Children in Ungwan Kugu, Zaria

Risk Factors	(n) Secondary School	Number positive (%)	*P-value	Odds Ratio (OR)	(n) Primary School	Number positive (%)	*P-value	Odds Ratio (OR)
Awareness								
No	54	9(17.7)	0.613	0.750	11	6(54.5)	0.000	0.050
Yes	46	6(13.0)		1.333	89	5(5.6)		20.160
Irrigation farming								
No	69	3(4.3)	0.000	13.895	66	5(7.6)	0.127	2.614

Science World Journal Vol. 20(No 4) 2025 https://dx.doi.org/10.4314/swj.v20i4.33
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Yes	31	12(38.7)		0.072	34	6(17.6)		0.383
Swimming								
No	75	5(6.7)	0.000	9.333	71	0(0.0)	0.000	n.a
Yes	25	10(40.0)		0.107	29	11(37.9)		n.a
Fishing								
No	79	5(6.3)	0.000	13.455	82	5(6.1)	0.010	7.700
Yes	21	10(47.6)		0.074	18	6(33.3)		0.130
Place for washing								
Home	93	9(9.7)	0.000	56.000	83	0(0.0)	0.000	n.a
Stream	7	6(85.7)		0.019	17	11(64.7)		n.a
Source of water								
Borehole	10	1(10.0)	0.641	1.658	48	3(6.2)	0.003	n.a
Stream	0	0(0.0)			13	5(38.5)		
Well	90	14(15.6)		0.603	39	3(7.7)		

n.a = Not applicable; n = Number examined; *Chi Square analysis (χ^2)

Table 3: Signs/Symptoms of Urinary Schistosomiasis among Secondary and Primary Children in Ungwan Kugu, Zaria

Signs/ Symptoms	(n) Secondary School	Number positive (%)	*P-value	(n) Primary School	Number positive (%)	*P-value
Painful urination						
No	69	2(2.9)	0.000	60	5(8.3)	0.297
Yes	31	13(41.9)		40	6(15.0)	
Frequent Urination						
No	71	6(8.5)	0.004	65	4(6.2)	0.035
Yes	29	9(31.0)		35	7(20.0)	
Abdominal pain						
No	71	6(8.5)	0.004	63	4(6.3)	0.050
Yes	29	9(31.0)		37	7(18.9)	
Terminal haematuria						
No	84	2(2.4)	0.000	82	1(1.2)	0.000
Yes	16	13(81.2)		18	10(55.6)	

n.a = Not applicable; n = Number examined; *Chi Square analysis (χ^2)

Table 4: Comparative Identification of Urinary Analytes of Urinary Schistosomiasis among Secondary and Primary Children in Ungwan Kugu, Zaria

Urinary Analytes	**Category**	**(n) Secondary School**	**Number positive (%)**	**P-value**	**(n) Primary School**	**Number positive (%)**	**P-value**
Leukocytes	Absent	83	5(6.0)	0.000	82	5(6.1)	0.001
	Present	17	10(58.8)		18	6(33.3)	
Nitrite	Absent	77	12(15.6)	0.765	70	6(8.6)	0.236
	Present	23	3(13.0)		30	5(16.7)	
Urobilinogen	Normal	89	14(15.7)	0.561	95	10(10.5)	0.509
	High	11	1(9.1)		5	1(20.0)	

Science World Journal Vol. 20(No 4) 2025 https://dx.doi.org/10.4314/swj.v20i4.33
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Proteins	Absent	89	8(9.0)	0.000	94	8(8.5)	0.002
	Present	11	7(63.6)		6	3(50.0)	
pH	5	9	0(0.0)	0.349	22	2(9.1)	0.587
	6	70	11(15.7)		50	6(12.0)	
	7	4	0(0.0)		9	2(22.2)	
	8	17	4(23.5)		19	1(5.3)	
Microhaematuria	Absent	84	1(1.2)	0.000	91	2(2.2)	0.000
	Present	16	14(87.5)		9	9(100.0)	
Specific gravity	≤1.015	34	5(14.7)	0.953	55	3(5.5)	0.050
	>1.015	66	10(15.2)		45	8(17.8)	
Ketones	Absent	91	13(14.3)	0.525	90	9(10.0)	0.338
	Present	9	2(22.2)		10	2(20.0)	
Bilirubin	Absent	84	10(11.9)	0.047	84	9(10.7)	0.834
	Present	16	5(31.2)		16	2(12.5)	
Glucose	Absent	99	15(15.2)	0.673	100	11(11.0)	C
	Present	1	0(0.0)		0	0(0.0)	
Ascorbic acid	Absent	100	15(15.0)	C	92	9(9.8)	0.187
	Present	0	0(0.0)		8	2(25.0)	

C = Constant; n = Number examined

DISCUSSION

Detection of urinary schistosomiasis in this study confirmed the persistence of the disease among children in Nigerian rural areas. Comparatively, children in secondary school in Ungwan Kugu had higher infection than children in primary school. This may likely be due to the fact that children in secondary school were relatively older and engaged more actively in activities that could have predisposed them more to the infections than the younger children. Previous studies by Bishop and Ahmadu (2018) and Markus and Bishop (2024) both reported a similar pattern of age-distribution of urinary schistosomiasis among school children. The males were more infected than the females in both groups. This is consistent with many reports (Bigwan *et al.*, 2013; Bishop and Akoh, 2018). Male children are more eager and often indiscriminately engage in open water-contact activities than the females, especially in the northern part of the country where socio-cultural and religious beliefs restrict female children from open water-based activities like bathing and swimming in rivers and streams (Markus and Bishop, 2024).

Indiscriminate water-contact activities in unsafe water bodies bring children in contact with cercariae of schistosomes which ensue infections. Direct contact with cercarial-infested water during out-door or domestic activities leads to exposure; however, significant among them are swimming, fishing, washing in streams in both groups of children. Irrigation farming was mainly conducted by relatively older children in secondary school, who were significantly predisposed. Lack of awareness stood as a significant risk factor only among the primary school children because they were relatively younger, naïve and unaware of the danger of unsafe water bodies in which they played (Bishop and Ahmadu, 2018; WHO, 2023).

Infection with schistosomes affects the health of children. This was evident given the presentation of symptoms that included frequent urination, abdominal pain, terminal haematuria and painful urination among the school children. Bishop *et al.* (2016) reported similar symptoms among primary school children. These symptoms have been classically associated with urinary schistosomiasis (Cheesbrough, 2009; Dawaki *et al.,* 2015; Bishop *et al.,* 2016; WHO, 2023).

Where symptoms are not evident, probably due to light infection or during the early phase of the infection, detection of urinary analytes via urinalysis may be helpful in establishing a diagnosis (Zhang *et al.*, 2015). Such analytes are chemical indicators in urine that are indicative of an altered physiology (Zamanzad, 2009; Onile *et al.*, 2017; Bishop, 2024). Urine samples of infected children in this study significantly had leukocytes, proteins, microhaematuria and specific gravity above 1.015 as significant analytes for possible diagnosis of urinary schistosomiasis. This is consistent with previous reports by Bishop (2024) and Vere *et al.* (2025). These significantly-associated analytes in urinary schistosomiasis can serve as biomarkers for diagnosis of the infection (Vere *et al.*, 2025).

Conclusion

Comparatively, this study found 15.0% and 11.0% occurrence of urinary schistosomiasis among children in secondary and primary

schools respectively. The infection occurred significantly higher among the males. Older children between 18-20years old were significantly more infected. Swimming, fishing, washing in streams and irrigation farming were identified as significant risk factors of the disease; while the significant symptoms included frequent urination, abdominal pain and terminal haematuria and painful urination. The study established proteins and microhaematuria and urine specific gravity above 1.015 as significant analytes of the infection.

REFERENCES

Bigwan, E.I., Kunihya, R.Z. and John, T.J. (2013). Epidemiological survey of urinary schistosomiasis among primary school children in Michika, Adamawa State, North-Eastern Nigeria. *International Journal of Current Research and Review,* 5(5):111-116

Bishop, H.G. (2017). Menace of Schistosomiasis: Its True Neglected Nature in Nigeria. *MOJ Public Health*, 6(5): 00186. https://doi.org/10.15406/mojph.2017.06.00186

Bishop, H.G. (2024). Detection of Urinary Analytes due to *Schistosoma haematobium* infection among school children for possible application in screening for urinary schistosomiasis. *UMYU Journal of Microbiology Research,* 9(3):350-358. https://doi.org/10.47430/ujmr.2493.042

Bishop, H.G. and Ahmadu, J.M. (2018). *Schistosoma haematobium* and *Klebsiella pneumoniae* co-infections, antibiotic susceptibility and multiple antibiotic resistance index in school children in Zaria, Nigeria. *Health Research*, 2:24-33. https://dx.doi.org/10.31058/j.hr.2018.23003

Bishop, H.G. and Akoh, R.I. (2018) Risk factors, symptoms and effects of urinary schistosomiasis on anthropometric indices of school children in Zaria, Kaduna State, Nigeria. *Open Access Journal of Science*, 2(1): 00045. https://doi.org/10.15406/oajs.2018.02.00045

Bishop, H.G., Inabo, H.I. and Ella E.E. (2016). Prevalence and intensity of urinary schistosomiasis and their effects on packed cell volume of pupils in Jaba LGA, Nigeria. *Edorium Journal of Microbiology*, 2:13-26

Bishop, H.G., Inabo, H.I., Ella, E.E. and Bello, M. (2023). Urinary schistosomiasis: risk factors and symptoms among school adolescents in Kaduna State, Nigeria. *EUREKA: Life Science*, 2(44):56-62. https://dx.doi.org/10.21303/2504-5695.2023.002905

Cheesbrough, M. (2009). *District Laboratory Practice in Tropical Countries,* Part I, 2nd ed. updated. Cambridge University Press, Cambridge, UK.

Dawaki, S., Al-Mekhlafi, H.M., Ithoi, I., Ibrahim, J., Abdulsalam, A.M., Ahmed, A., Sady, H., Nasr, N.A. and Atroosh, W.M. (2015). The menace of schistosomiasis in Nigeria: knowledge, attitude, and practices regarding schistosomiasis among rural communities in Kano State. *PLoS ONE,* 10(11):e0143667. https://dx.doi.org/10.1371/journal.pone.0143667

Markus, D.A and Bishop, H.G. (2024). Prevalence of urinary schistosomiasis among school children in Giwa and Markafi Local Government Areas, Kaduna State, Nigeria. *Science World Journal*, 19(1):224-228. https://dx.doi.org/10.4314/swj.v19i1.29

Onile, O.S., Calder, B., Soares, N.C., Anumudu, C.I., Blackburn, J.M. (2017). Quantitative label free proteomic analysis of human urine to identify novel candidate protein biomarkers for schistosomiasis. *PLoS Neglected Tropical Diseases*, 11(11):e0006045

Oyibo, E.U., Khalid, A., Muhammad, A.S. and Agwu, N. P. (2023). Genitourinary complications of schistosomiasis. *International Journal of Medical Science and Dental Research*, 6(2):1-19.

Santos, L.L., Santos, J., Gouveia, M.J., Bernardo, C., Lopes, C., Rinaldi, G., Brindley, P.J., Costa, J.M.C. (2021). Urogenital schistosomiasis—history, pathogenesis, and bladder cancer. *Journal of Clinical Medicine, 10*, 205. https://doi.org/10.3390/jcm10020205

Van der Werf, M.J. and de Vlas, S.J. (2004). Diagnosis of urinary schistosomiasis: a novel approach to compare bladder pathology measured by ultrasound and three methods for hematuria detection. *American Journal of Tropical Medicine and Hygiene*, 7(1): 98-106.

Vere, M., Ham-Baloyi, W.T., Oyedele, O., Mduluza, T. and Melariri, P. (2025). Urinary biomarkers and haematuria as indicators f urogenital schistosomiasis: a systematic review and meta-analysis *Acta Tropica*, 269:107716. https://doi.org/10.1016/j.actatropica.2025.107716

Weerakoon, K.G.A.D., Gobert, G.N., Cai, P. and McManus, D.P. (2015). Advances in the diagnosis of human schistosomiasis. *Clinical Microbiology Reviews*, 28(4):939-967. https://doi.org/10.1128/CMR.00137-14

WHO (2023). Schistosomiasis. Released 1st February 2023, accessed on 7th December, 2025 from: https://www.who.int/news-room/fact-sheets/detail/schistosomiasis

Zamanzad, B. (2009). Accuracy of dipstick urinalysis as a screening method for detection of glucose, protein, nitrites and blood. *Eastern Mediterranean Health Journal,* 15(5):1323-1328.

Zhang, Y., Zhao, J., Wang, X., Xu, X. and Pan, W. (2015). Evaluation of six novel antigens as potential biomarkers for the early immunodiagnosis of schistosomiasis. *Parasites & Vectors*, 8:477-454.