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Distribution Of Urogenital Schistosomiasis Infection In Relation To Haemoglobin Levels And Nutritional Status In Primary School Children In Taraba State, Nigeria

Agbo O. J., Houmsou R. S., Elkanah O. S.
Department Of Biosciences, Federal University Wukari, Taraba State, Nigeria
Department Of Biological Sciences, Faculty Of Science, Taraba State University, Jalingo, Nigeria

Abstract
Introduction: *Urogenital schistosomiasis, caused by* Schistosoma haematobium, *remains a significant public health challenge, especially in tropical regions. It is associated with numerous health issues such as anemia, malnutrition, and developmental delays. In Nigeria, the disease is hyperendemic, particularly affecting school-aged children who are often exposed to contaminated water sources.*
Aim: *The study aims to assess the prevalence and distribution of urogenital schistosomiasis, focusing on its association with hemoglobin levels and body mass index (BMI) in primary school children across different regions of Taraba State.*
Methodology: *A cross-sectional survey was conducted in six local government areas of Taraba State. A total of 1,373 primary school children, aged 3-16 years, participated. Urine samples were collected and examined for* S. haematobium *eggs. BMI was calculated using weight and height measurements, while hemoglobin levels were determined using a portable hemoglobin meter. Data were analyzed for prevalence and correlations between infection, anemia, and nutritional status.*
Results: *The overall prevalence of urogenital schistosomiasis was 7.7%, with a significantly higher infection rate observed among children with severe anemia (79.7%). Infection was more prevalent in underweight children (12.8%) and those with low BMI. Haematuria was identified as a strong indicator of infection, with 79.1% of children with haematuria testing positive for schistosomiasis.*
Conclusion: *The study reveals a significant association between urogenital schistosomiasis and factors such as anemia and undernutrition. These findings underline the importance of integrated public health interventions targeting nutrition, anemia control, and early diagnosis through haematuria screening to reduce the disease burden in endemic areas.*
Keywords: *Urogenital schistosomiasis,* Schistosoma haematobium, *hemoglobin levels, nutritional status, anemia, body mass index (BMI).*

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I. Introduction

Schistosomiasis, a disease caused by parasitic trematodes of the genus *Schistosoma*, continues to be a significant public health challenge in tropical and subtropical regions, particularly in Sub-Saharan Africa. Among the various species, *Schistosoma haematobium* is the causative agent of urogenital schistosomiasis, affecting the urinary tract and contributing substantially to morbidity among vulnerable populations, especially children (WHO, 2020). Infection typically occurs through skin contact with infested freshwater sources, where cercariae released by intermediate snail hosts penetrate the skin, leading to parasitic colonization. The pathological manifestations are primarily due to the body's inflammatory response to parasite eggs trapped in tissues, causing haematuria, anemia, and long-term damage to the urogenital tract (Colley *et al*., 2014; Secor, 2021).

In Nigeria, schistosomiasis remains hyperendemic, with approximately 29 million people infected and over 100 million at risk, making it the country with the highest disease burden globally (Hotez *et al*., 2020). *S. haematobium* infection is especially prevalent in rural and remote communities where access to clean water, sanitation, and healthcare is limited.

Taraba State, located in northeastern Nigeria, is one of such high-risk areas, characterized by extensive freshwater bodies, rice cultivation, and community-level water contact activities such as bathing, fishing, and washing in stagnant ponds and rivers. Despite ongoing Mass Drug Administration (MDA) campaigns with praziquantel, reinfection rates remain high, particularly among school-aged children (Ajakaye *et al*., 2021; Adekeye *et al*., 2023).

Children are the most vulnerable demographic to urogenital schistosomiasis due to their frequent water-contact behaviors and underdeveloped immune responses. More concerning is the growing body of evidence linking schistosomiasis infection to poor nutritional status and anemia, which may exacerbate the disease burden and impair cognitive and physical development (Musaazi *et al.*, 2022). Chronic blood loss due to haematuria and the inflammation associated with egg retention are known contributors to iron-deficiency anemia and low haemoglobin concentrations in infected children. Likewise, malnutrition and stunted growth have been observed in schistosomiasis-endemic communities, although the causal relationships remain under-investigated, particularly in Nigerian settings (Lukeman *et al*., 2021).

The interaction between parasitic infections, nutritional health, and hemoglobin levels has become a growing public health concern. Yet, there remains a paucity of location-specific data from Taraba State that links *S. haematobium* infection with hemoglobin concentration and nutritional indices such as body mass index (BMI). This gap in the literature limits the ability of health authorities to design targeted interventions that address the multifactorial dimensions of schistosomiasis-related morbidity. Additionally, geographical disparities in disease distribution, driven by environmental and socioeconomic factors, call for the incorporation of spatial epidemiological tools like Geographic Information Systems (GIS) to better understand disease dynamics and prioritize high-risk zones (Brooker *et al*., 2021; Okeke *et al*., 2022).

This study, therefore, aims to assess the distribution of urogenital schistosomiasis infection in relation to haemoglobin levels and nutritional status (BMI) among primary school children in various zonal locations of Taraba State. Given the high disease burden and the associated risk of anemia and malnutrition, this research is both timely and essential. It offers critical insight for public health stakeholders and policymakers to implement more integrated, data-driven control strategies that go beyond chemotherapy to include nutritional support, anemia screening, and environmental risk mapping.

Ultimately, the findings from this study are expected to inform localized interventions, strengthen school-based health education programs, and promote sustainable disease surveillance and control frameworks. By integrating parasitological, hematological, and nutritional data within a geographical context, this research provides a comprehensive view of the multifaceted impact of urogenital schistosomiasis on child health in Taraba State, Nigeria.

II. Materials And Methods

Study Area

The study was conducted in Taraba State, Nigeria, located between latitude 8°00′00″ N and longitude 10°30′00″ E. According to the National Population Commission (NPC, 2006), the state has an estimated population of 2,294,800 and a total land area of 54,473 km². It shares boundaries with Nasarawa and Benue States to the southwest, Plateau State to the northwest, Bauchi and Gombe States to the north, and Adamawa State to the northeast. The southern border lies adjacent to the Northwest and Adamawa regions of Cameroon. The climate is predominantly tropical, characterized by lowland rainforest in the south and grassland savannah in the north (Akogun, 1999).

Ethnic groups in the state include the Jukun, Kuteb, and Ichen in the south, Wurkum, Mumuye, and Jukun Kona in the north, and the Mambila, Chamba, Fulani, and Jibawa in the central zone (Barau et al., 2020). Six local government areas (LGAs) with proximity to freshwater bodies were selected for the study: Lau and Karim-Lamido (north), Bali and Sardauna (central), and Donga and Ibi (south). In each LGA, five primary schools from five different communities were selected, resulting in a total of 30 primary schools (10 from each geopolitical zone).

Study Population

The study population comprised male and female pupils aged 3–16 years, enrolled in the selected primary schools. Participants were selected using a simple random sampling method.

Sample Size Determination

Sample size was calculated using the formula by Charan and Biswas (2013):

$$N = \frac{Z^2 P(1-P)D}{E^2}$$

Where:

- P = expected prevalence (0.1 or 10%)
- E = margin of error (10% of P = 0.05)
- Z = standard normal deviate for 95% confidence level (1.96)
- D = design effect (assumed to be 1 for simple random sampling)

$$N = \frac{(1.96)^2\ 0.1(1-0.1)}{}$$

$(0.05)^2$
N = 0.345744
0.0025
N = 138.3
A minimum of 138 participants was therefore required for the study.

Inclusion and Exclusion Criteria
Inclusion: Pupils aged 3–16 years attending the selected schools that provided consent and completed the study questionnaire.
Exclusion: Children in the community who were not enrolled in the selected schools.

Questionnaire Administration
A structured questionnaire was used to obtain demographic and socio-economic information, including age, gender, class, parents' occupation and education, and frequency of water contact activities.

Urine Sample Collection and Examination
Each selected pupil was instructed to provide a 10 mL mid-day urine sample (collected between 10:00 and 14:00 hours, the peak period for Schistosoma haematobium egg excretion) in a sterile 20 mL universal container. Containers were appropriately labeled to match questionnaire codes. Samples were transported to the nearest primary health care laboratory for parasitological analysis.

Urine samples were examined for *S. haematobium* eggs using the urine filtration method recommended by the World Health Organization (WHO, 2002). Specifically, 10 mL of each urine sample was filtered through a 12 µm pore-size polycarbonate membrane using a 13 mm diameter Swinnex® filter holder (Sterlitech Corp., USA). The membrane filters were placed on microscope slides and examined under 10x and 40x objectives. Positive samples were quantified as eggs per 10 mL of urine and classified based on WHO criteria as light (1–50 eggs/10 mL) or heavy (>50 eggs/10 mL) intensity of infection.

Anthropometric Assessment
Participants' anthropometric measurements, including weight, body mass index (BMI), fat percentage, muscle mass, body water content, visceral fat, bone mass, basal metabolic rate, protein percentage, and obesity index, were assessed using a digital body composition scale. Children were weighed barefoot and without any heavy clothing. Measurements were recorded to the nearest 0.1 kg. Nutritional status was evaluated using WHO growth standards for school-aged children and adolescents (WHO AnthroPlus, Geneva, Switzerland).

Haemoglobin Level Determination
Haemoglobin levels were measured using the Urit H12 haemoglobin meter (Urit Medical Electronic Co. Ltd., China) with compatible reagent strips. A finger prick blood sample was collected and applied to the test strip for immediate analysis. Results were interpreted as follows:
- Severe anaemia: <8.0 g/dL
- Moderate anaemia: 8.0–10.9 g/dL
- Mild anaemia: 11.0–11.9 g/dL
- Normal (non-anaemic): ≥11.5 g/dL

Additionally, a drop of blood was blotted onto Whatman filter paper, air-dried, and stored at room temperature for subsequent molecular analysis.

Ethical Considerations
Ethical approval was obtained from the Taraba State Ministry of Health, Jalingo (Health Research Ethics Committee approval number: TRSHREC/2024/050). Permission was also sought from the local government administrative and health authorities, as well as from head teachers of the participating schools. Pupils received orientation regarding the study's purpose and procedures and were required to obtain written informed consent from their parents or guardians.

III. Results

Prevalence of Urogenital Schistosomiasis in Relation to Body Mass Index (BMI)
Table 1 presents the distribution of urogenital schistosomiasis prevalence across different BMI categories. The highest prevalence of infection (12.8%, n=76/594) was observed among participants classified as underweight (BMI <18.5). This was followed by those within the normal weight range (BMI 18.5-25.9), with a prevalence of 3.9% (n=30/774). No cases of urogenital schistosomiasis were detected among the overweight

group (BMI 25-29.9), which consisted of 5 individuals. A statistically significant association was observed between BMI categories and the prevalence of urogenital schistosomiasis (*P*<0.05).

Table 1: Prevalence of Urogenital Schistosomiasis based on Body Mass Index (BMI)

BMI	NO EXAMINED	NO. POSITIVE (%)
<18.5	594	78 (13.10)
18.5-24.9	774	30 (3.90)
25-29.9	5	0 (0.00)
Total	1373	108 (7.90)

(χ^2 = 37.943; *p*<0.05)

Prevalence and Intensity of Urogenital Schistosomiasis According to Socio-demographic Factors

Table 2 summarizes the prevalence and intensity of urogenital schistosomiasis in relation to various socio-demographic factors. The overall prevalence of urogenital schistosomiasis was 7.9% (n=108/1373), with 6.1% (n=84) of cases classified as having fewer than 50 eggs per 10 ml of urine, and 1.7% (n=24) having more than 50 eggs per 10 ml. Bali Local Government Area had the highest prevalence (13.1%), while Lau Local Government Area had the lowest prevalence (3.5%). Prevalence was slightly higher among males (8.0%) compared to females (7.5%), though this difference was not statistically significant (*P*>0.05). Egg intensity did not differ significantly between genders, suggesting comparable exposure levels. The highest infection rate was observed in the 13-17 age group (9.3%, n=25), while the lowest was found in the 3-7 age group (7.3%, n=9). Participants whose mothers had no formal education exhibited a higher prevalence (11.3%), while those with parents employed as civil servants had the highest prevalence (12.8%).

Table 2: Prevalence and Intensity of Urogenital Schistosomiasis based on Socio-demographic Variables

Variable	No. Examined	No. Positive (%)	<50 egg/10ml (%)	>50 egg/10ml (%)
Location				
Donga	226	16 (7.1)	10 (4.4)	6 (2.7)
Ibi	226	16 (7.1)	11 (4.9)	5 (2.2)
Bali	228	30 (13.1)	27 (11.8)	3 (1.3)
Lau	226	8 (3.5)	8 (3.5)	0 (0.0)
Sadauna	233	20 (8.6)	18 (7.7)	2 (0.9)
Karim Lamido	234	18 (7.7)	10 (4.3)	8 (3.4)
Total	**1373**	**108 (7.9)**	**84 (6.1)**	**24 (1.7)**
Gender				
Male	702	57 (8.1)	43 (6.1)	14 (2.0)
Female	671	51 (7.6)	41 (6.1)	10 (1.5)
Total	**1373**	**108 (7.9)**	**84 (6.1)**	**24 (1.7)**(x= 0.509; p>0.05)
Age (Years)				
3-7	124	9 (7.3)	8 (6.5)	1 (0.8)
6-12	980	74 (7.6)	59 (6.0)	15 (1.5)
13-17	269	25 (9.3)	17 (6.3)	8 (3.0)
Total	**1373**	**108 (7.9)**	**84 (6.1)**	**24 (1.7)**(x= 3.338; p>0.05)
Mother's Education				
No Formal Education	434	49 (11.3)	37 (8.5)	12 (2.8)
Primary	458	23 (4.6)	17 (3.7)	6 (1.3)
Secondary	402	30 (5.0)	24 (6.0)	6 (1.5)
Tertiary	79	6 (7.6)	6 (7.6)	0 (0.0)
Total	**1373**	**108 (7.9)**	**84 (6.1)**	**24 (1.7)**(x=14.305; p<0.05)
Father's Education				
No Formal Education	380	44 (11.6)	35 (9.2)	9 (2.4)
Primary	242	12 (5.0)	10 (4.1)	2 (0.8)
secondary	532	35 (6.6)	24 (4.5)	11 (2.1)
Tertiary	219	17 (7.8)	15 (6.8)	2 (0.9)
Total	**1373**	**108 (7.9)**	**84 (6.1)**	**24 (1.7)**(x=14.019; p<0.05)
Mother's Occupation				
Farmer	523	32 (6.1)	24 (2.6)	8 (1.5)
Trader/Business	789	71 (9.0)	56 (7.1)	15 (1.9)
Civil Servant	61	5 (8.2)	4 (6.6)	1 (1.6)
Total	**1373**	**108 (7.9)**	**84 (6.1)**	**24 (1.7)**(x= 3.792; p>0.05)

Father's Occupation				
Farmer	603	40 (6.6)	27 (4.5)	13 (2.2)
Trader/Business	637	51 (8.0)	42 (6.6)	9 (1.4)
Civil Servant	133	17 (12.8)	15 (11.3)	2 (1.5)
Total	**1373**	**108 (7.9)**	**84 (6.1)**	**24 (1.7)**(x=10.154; p<0.05)

(χ^2= 46.117; p<0.05)

Prevalence of Urogenital Schistosomiasis in Relation to Anemia Severity

Table 3 shows the prevalence of urogenital schistosomiasis according to the severity of anemia among participants. Among the 199 non-anemic individuals, 3 (1.5%) tested positive for urogenital schistosomiasis. In the mild anemia group (n=8), no cases of schistosomiasis were detected. Among individuals with moderate anemia (n=1107), 56 (5.1%) were positive for urogenital schistosomiasis. In contrast, the prevalence was significantly higher in those with severe anemia (n=59), where 47 (79.7%) tested positive.

Overall, 106 out of 1373 participants tested positive for urogenital schistosomiasis, yielding a prevalence rate of 7.7%. A chi-square analysis (X^2 = 451.066) revealed a statistically significant association between the severity of anemia and the prevalence of urogenital schistosomiasis ($P<0.05$).

Table 3: Prevalence of Urogenital Schistosomiasis based on Anaemic Status in the Study Areas

ANAEMIC STATUS	NO. EXAMINED	NO. POSITIVE (%)
Non – Anaemic	199	3 (1.50)
Mild	8	0 (0.00)
Moderate	1107	56 (5.10)
Severe	59	47 (79.70)
Total	1373	106 (7.70)

(χ^2 = 451.066; $p<0.05$)

Prevalence of Urogenital Schistosomiasis Associated with Haematuria

Table 4 presents the relationship between haematuria and urogenital schistosomiasis prevalence. Among 1287 individuals who tested negative for haematuria, 1241 (96.4%) were negative for schistosomiasis by Filtration, while 46 (3.6%) were positive. In contrast, among the 67 individuals who tested positive for haematuria, 53 (79.1%) were positive for urogenital schistosomiasis, while 14 (20.9%) were negative. This indicates a significantly higher prevalence of urogenital schistosomiasis among individuals with haematuria (79.1%) compared to those without (3.6%).

Table 4: Haematuria-associated prevalence of Urogenital Schistosomiasis in the Study Areas

HEMATURIA STATUS	FILTRATION		
	NEGATIVE	POSITIVE	TOTAL (%)
Negative	1241	46	1287 (95.10)
Positive	14	53	67 (4.90)
Total	1255 (92.70)	99 (7.30)	1354 (100)

IV. Discussion

This study aimed to investigate the distribution of urogenital schistosomiasis infection in relation to various factors, including body mass index (BMI), anemia severity, and the presence of haematuria, among primary school children in Taraba State, Nigeria. The findings highlight several significant associations, which provide insights into the epidemiology of urogenital schistosomiasis in this region and its potential links with nutritional and health status.

The study found a significant association between Body Mass Index (BMI) and the prevalence of urogenital schistosomiasis. Specifically, the highest prevalence was observed in the underweight group (12.8%), followed by those with a normal BMI (3.9%), while no cases were found in the overweight group. This suggests that undernutrition or poor nutritional status may predispose individuals to increased susceptibility to urogenital schistosomiasis infection. A possible explanation for this could be that malnutrition weakens the immune system, rendering individuals more susceptible to parasitic infections like schistosomiasis (Sung *et al*., 2020).

This finding is consistent with similar studies conducted in other regions, which have observed higher rates of schistosomiasis among undernourished populations. For example, a study by Silva *et al*. (2021) in

Brazil reported a higher prevalence of schistosomiasis among individuals with lower BMI, suggesting that nutritional deficiencies could compromise the host's ability to mount an effective immune response. Additionally, lower BMI has been linked to a reduced ability to tolerate and recover from infections (Hernandez *et al*., 2022).

Furthermore, the findings show a prevalence rate of 7.9% overall, with notable variations across different socio-demographic factors. The highest prevalence was observed in Bali Local Government Area (13.1%), while Lau had the lowest (3.5%). These differences could reflect geographical variations in exposure, water contact behaviors, and access to preventive measures such as sanitation and health education. The higher prevalence among males (8.0%) compared to females (7.5%) is consistent with findings from other studies, although the difference was not statistically significant (Yousef *et al*., 2021).

The age group 13-17 years had the highest infection rate (9.3%), which may reflect increased exposure to contaminated water sources due to activities such as fishing or farming, which are more common in older children (Abdullah *et al*., 2020). The higher prevalence among children whose mothers had no formal education (11.3%) could indicate a lack of awareness regarding preventive measures, such as avoiding contact with contaminated water sources. Similarly, parents with civil service jobs having the highest prevalence (12.8%) suggests that socio-economic factors might influence both access to preventive health care and the likelihood of exposure to infected water bodies.

The relationship between anemia and urogenital schistosomiasis was particularly striking. Among participants with severe anemia, 79.7% tested positive for urogenital schistosomiasis. This high prevalence indicates a strong association between schistosomiasis and anemia, with the latter possibly resulting from chronic schistosomiasis infection due to the parasite’s blood-feeding activity, which can lead to significant blood loss over time (Mutapi *et al*., 2020). Additionally, schistosomiasis has been shown to exacerbate iron deficiency anemia, a common consequence of chronic infections. This finding is corroborated by studies from Sub-Saharan Africa, which have consistently demonstrated a higher prevalence of anemia in individuals infected with schistosomiasis (Chitsulo *et al*., 2021).

This study also observed that individuals with moderate anemia had a prevalence of 5.1%, indicating that even moderate forms of anemia are associated with an increased risk of schistosomiasis infection. These results align with research by Vlassoff *et al*. (2021), which found that both iron deficiency and anemia are prevalent in areas with high schistosomiasis transmission, potentially creating a vicious cycle that exacerbates the public health burden.

Haematuria, a common clinical symptom of urogenital schistosomiasis, was strongly associated with infection in the study. Among individuals with haematuria, 79.1% tested positive for urogenital schistosomiasis, compared to only 3.6% among those without haematuria. This highlights haematuria as a significant clinical indicator of urogenital schistosomiasis infection. The presence of blood in the urine is a well-documented symptom of schistosomiasis, resulting from the inflammation and damage caused by the eggs of *Schistosoma haematobium* in the urinary tract (Molyneux *et al*., 2021).

These findings are in agreement with studies conducted in other endemic regions, where haematuria was consistently identified as a key marker for schistosomiasis infection. For instance, a study by Dube *et al*. (2022) in Mozambique also found a high prevalence of schistosomiasis among individuals with haematuria, emphasizing the clinical utility of this symptom for diagnosis.

This study reveals several critical associations between urogenital schistosomiasis and factors such as BMI, anemia, socio-demographic characteristics, and haematuria. The findings underscore the importance of addressing nutritional deficiencies and anemia in schistosomiasis control programs, as well as improving public health interventions targeting high-risk groups.

Recent research supports the findings, with studies highlighting the role of malnutrition and anemia in increasing susceptibility to schistosomiasis (Mutapi *et al*., 2020; Yousef *et al*., 2021), as well as the significant clinical relationship between haematuria and infection (Dube *et al*., 2022). These findings suggest that multi-faceted interventions, including improving nutritional status, enhancing education, and addressing anemia, are critical to reducing the burden of urogenital schistosomiasis in endemic areas.

V. Conclusion

This study demonstrates significant associations between urogenital schistosomiasis infection and factors such as Body Mass Index (BMI), anemia, and haematuria among primary school children in Taraba State, Nigeria. The findings highlight that undernutrition and anemia, particularly severe anemia, increase susceptibility to schistosomiasis. Haematuria was identified as a strong clinical indicator of the infection. These results emphasize the need for comprehensive public health interventions targeting improved nutrition, anemia control, and early diagnosis through haematuria screening to mitigate the burden of urogenital schistosomiasis in endemic regions.

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