Open Access Library Journal
2025, Volume 12, e12810
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Prevalence of Urinary Tract Pathology among Pupils Infected with Urinary Schistosomiasis and Those Not Infected with the Infection in Ndokwa-East Lga of Delta State, Nigeria

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How to cite this paper: Mbagwu, N.E., Ajaegbu, O.C., Ezeonwu, B.U., Agabi, J.O., Okwudinka, I.O. and Okolo, S.N. (2025) Prevalence of Urinary Tract Pathology among Pupils Infected with Urinary Schistosomiasis and Those Not Infected with the Infection in Ndokwa-East Lga of Delta State, Nigeria. *Open Access Library Journal*, **12**: e12810.
https://doi.org/10.4236/oalib.1112810

Received: December 12, 2024
Accepted: January 20, 2025
Published: January 23, 2025

Abstract

Background: The prevalence of urinary schistosomiasis has remained relatively high, particularly in Sub-Saharan Africa. The urinary tract pathology (UTP) of urinary schistosomiasis is a common complication of the infection, and it is a disease of major public health importance, especially in developing countries with poor health resources. **Objective**: The aim of this study was to determine the prevalence and the pattern of urinary tract ultrasonographic abnormalities among primary school children with urinary schistosomiasis and those without the infection in Ndokwa-East Local Government Area (NELGA) of Delta State. **Methods:** This study was a cross sectional comparative study of primary school children aged 5-15 years in Ndokwa-East Local Government Area (NELGA) of Delta State. Urine microscopy was used to separate infected and uninfected primary school pupils, after which they participated in an ultrasound examination for urinary tract pathologies, using World Health Organization (WHO) guidelines for schistosomiasis morbidity. **Results**: The Urinary tract ultrasonographic abnormalities identified among the infected subjects were bladder wall pathologies (77.3%), hydronephrosis (40.9%) and hydroureter (9.1%), while bladder wall pathologies (13.6%) were the only UTP identified among uninfected subjects. The odds of having UTP were over 20 times higher among the infected cases than the uninfected controls: OR = 21.53 (95% C.I= 4.46-103.90). **Conclusion:** The prevalence of UTP was significantly higher among schistosomiasis-infected pupils when compared to uninfected subjects in this study, further supporting the fact that UTP noted from this study may most likely be from urinary schistosomiasis.

Subject Areas

Urology

Keywords

Urinary Schistosomiasis, Urinary Tract Pathology, Ultrasonography, Hydroureter, Hydronephrosis, Bladder Wall

1. Introduction

Infection with *Schistosomiasis haematobium* is known to be associated with several complications of significant public health importance [1]-[3]. These complications include urinary tract abnormalities like granuloma formation with calcification in the bladder, ureters, and occasionally the kidneys, which may cause obstructive uropathy [1]. Other complications include renal parenchymal diseases like glomerulonephritis, nephrotic syndrome, and ultimately end stage renal disease (ESRD) [1]. Schistosomiasis is fundamentally an immunologic disease, and the pathogenesis of its acute, sub-acute, and chronic phases involves immunologic mechanisms [1]. The acute phase coincides with the invasion and migratory stages of the parasite's life cycle. The sub-acute phase is characterized by granuloma formation, predominantly in the bladder, lower ureters, seminal vesicles, prostate, and female genital tracts, depending on the quantity and location of schistosome eggs. These granulomas coalesce into tubercles, nodules, and masses that may ulcerate, causing dysuria, hematuria, and proteinuria. These masses can also obstruct urinary outflow, leading to hydronephrosis and hydroureter [1]-[3]. The resulting back pressure can cause renal damage, depending on the severity [1]. Urinary schistosomiasis is commoner among school-aged children [4]-[6]. School-aged children in endemic areas like Ndokwa-East Local Government Area (NELGA), of Delta State, Nigeria with persistent infection, are more likely to be exposed to the complications and could present with acute, sub-acute, and chronic urinary schistosomiasis, as reported from studies in other parts of Africa [7] [8]. There was a paucity of data confirming the morbidity of urinary schistosomiasis among children in NELGA.

The aim of this study is to evaluate the prevalence of urinary tract pathology among pupils infected with urinary schistosomiasis and those not infected with the infection in Ndokwa-East LGA of Delta State, Nigeria.

2. Subjects and Methods

The study was conducted in Ndokwa East LGA of Delta State, Nigeria. It was a cross sectional comparative study of primary school children aged 5 - 15 years in Ndokwa-East Local Government Area (NELGA) of Delta State, to determine the prevalence and the pattern of urinary tract ultrasonographic abnormalities among

primary school children with urinary schistosomiasis and those without the infection. Subjects' recruitment was initially done using a multistage, stratified sampling method. The wards and the primary schools were selected using a simple random sampling method. Urine microscopy (urine centrifugation-sedimentation method of diagnosis) was used to separate infected and uninfected primary school pupils. All the infected subjects proceeded to the second stage of the study, and Controls were selected from the uninfected pupils. The controls were matched according to community, age, gender, nutritional status and socio-economic class, in a 1:1 ratio.

The pupils were scanned in the morning. About 30 - 60 minutes before the procedure, each pupil was given at least 250 - 500 mls of sachet water to drink. This reduced the "shadows" cast by bowel gas, and improved the visibility of the urinary organs [9]. The kidneys, the ureters, and the bladder of all the subjects were scanned using a 3.5 Mhz curvilinear array transducer of a logic V5 ultrasound machine (GE Medical systems [CHINA] Co. Ltd, 2016).

The kidneys were assessed in the longitudinal and transverse axis for pathologies of the renal parenchymal and pelvi-calyceal collecting systems. The abnormalities were classified and scored according to the World Health Organization (WHO) guideline for schistosomiasis morbidity. The pathological lesions were classified into those affecting the bladder and those affecting the upper urinary tract (ureter and kidneys). For the bladder pathologies, the scores were given as follows: a wall irregularity with thickening up to 5mm is scored 1, and 2 if multifocal. A focal bladder wall thickening greater than 5mm was given a score of 1, and a score of 2 if multifocal. A mass considered as a localized thickening of the bladder wall, protruding into the lumen (>10 mm), was given a score of 2 when single and a score of n + 2 for multiple masses (n = number of masses). Pseudo polyps, defined as outgrowths of the wall, attached by slender bases (narrower than the mass), were scored like the masses. Each lesion in the wall was scored only once, in one category only [10].

Hydroureter was given a score of 3 when moderately dilated (the ureter being visualized at the proximal and/or distal third), and 4 when grossly dilated (the ureter being dilated more than is required for mere visualization).

Hydronephrosis was given a score of 6 if dilated with conserved parenchyma (distance between renal pelvis and capsule being > 1 cm), and a score of 8 if severely dilated with compression/absence of parenchyma (distance between renal pelvis and capsule being < 1 cm). Urinary tract lesions not meeting the above criteria were given scores of 0 [10].

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 22. Demographic characteristics and types of urinary tract abnormality were treated as categorical variables and expressed using frequency tables and charts. The significance of association between the prevalence of UTP and infection status was tested using chi-square test, Fisher's exact test and Odd's ratio when indicated. The level of significance was set at a p-value of less than 0.05.

Ethical Consideration

Ethical clearance was obtained from the Ethics Committee, FMC Asaba. Written permissions were obtained from the State Ministry of Basic and Secondary Education, and the Local Government Chairman. Verbal permission was obtained from the community leaders. Written informed consent was obtained from the parents/caregivers of the study participants and written assent was obtained from the participants aged ≥ 7 years.

Inclusion and exclusion criteria

All primary school children aged 5 - 15 years in selected communities whose parents gave informed consent were recruited for the study. Primary school children who had never been resident in NELGA in the last two months prior to this study were excluded from this study.

3. Results

General characteristics of the study population

There were 44 study participants: twenty-two (22) infected people who completed the study and their matched 22 non-infected controls. There were 26 males (59.1%) and 18 females (40.9%), giving a ratio of 1.4:1. They all belonged to the lower socio-economic status. The mean (SD) of weight, height, and body mass index (BMI) of the subjects were 26.4kg (11.7), 125.0cm (18.1), and 16.0kg/m^2 (3.3) respectively.

Prevalence and classification of UTP

Among the infected subjects that completed the study, 77.3% (17/22) had UTP using ultrasonography, while 13.6% (3/22) matched non-infected controls had UTP. The difference was statistically significant. (χ^2 = 17.97, df = 1, p =< 0.001). The odds of having UTP were over 20 times higher among the infected cases than the controls. OR = 21.53 (95% C.I = 4.46 - 103.90).

Seventeen (77.3%) out of the 22 infected pupils, and 13.6% of the non-infected Controls studied, had at least one abnormality of the bladder wall such as bladder mass, increased bladder wall thickness, abnormal bladder wall shape, and bladder wall irregularity (χ^2 = 17.967, df = 1, p =< 0.001) as shown in Table 1.

Table 1. Prevalence of bladder wall abnormalities, hydroureter and hydronephrosis in infected and uninfected subjects.

Abnormality	Infected (%) N = 22	Non-infected (%) N = 22	P-value
Bladder wall abnormalities	17 (77.3)	3 (13.6)	**<0.001***
No bladder wall abnormalities	5 (22.7)	19 (86.4)	
Hydroureter	2 (9.1)	0 (0.0)	0.488
No hydroureter	20 (90.9)	22 (100.0)	
Hydronephrosis	9 (40.9)	0 (0.0)	**0.001***
No hydronephrosis	13 (59.1)	22 (100.0)	

*= significant p-value.

Two (9.1%) out of the 22 infected pupils, and none of the uninfected controls had hydroureter. (df = 1, p = 0.488). Among infected pupils with hydroureter, two of them had moderate ureteric dilation.

Nine (40.9%) of the 22 infected pupils, and none of the uninfected controls had hydronephrosis of at least one kidney (df = 1, p = 0.001, Fisher's Exact Test). Among the 9 infected pupils with hydronephrosis, 4 (44.4%) of them had unilateral moderate hydronephrosis, 4 (44.4%) had bilateral moderate hydronephrosis, and 1 (11.1%) had severe hydronephrosis of the right kidney and moderate hydronephrosis of the left kidney. None of the uninfected controls had either hydroureter or hydronephrosis. The odds of having bladder wall pathology were over 20 times higher among the infected cases than the controls. OR = 21.53 (95% C.I = 4.46 - 103.90).

Table 2 shows the pattern and type of urinary tract abnormalities among infected Primary School Pupils by gender. Urinary tract abnormalities showed no gender predilection among infected subjects.

Table 2. Relationship between gender and prevalence of bladder wall abnormality, hydroureter, and hydronephrosis among infected subjects.

Parameter		Male	Female	P-value
Bladder wall abnormality	Yes	11 (84.6)	6 (66.7)	0.609
	No	2 (15.4)	3 (33.3)	
Hydroureter	Yes	1 (7.7)	1 (11.1)	1.000
	No	12 (92.3)	8 (88.9)	
Hydronephrosis	Yes	5 (38.5)	4 (44.4)	1.000
	No	8 (61.5)	5 (55.6)	

Table 3 shows the relationship between urinary tract pathology and age of the Subjects. The prevalence of bladder wall pathology, hydroureter, and hydronephrosis among infected subjects showed no age predominance. This is shown in Table 3.

Table 3. Relationship between urinary tract pathology and age of the subjects.

Pathology		5 - 9 years N = 9	10 - 13 years N = 10	14 - 15 years N = 3	p-value
Bladder wall pathology	Yes (%)	7 (77.8)	7 (70.0)	3 (100.0)	0.815
	No (%)	2 (22.2)	3 (30.0)	0 (0.0)	
Hydroureter	Yes (%)	0 (0.0)	1 (10.0)	1 (33.3)	0.260
	No (%)	9 (100.0)	9 (90.0)	2 (66.7)	
Hydronephrosis	Yes (%)	3 (33.3)	3 (30.0)	3 (100.0)	0.114
	No (%)	6 (66.7)	7 (70.0)	0 (0.0)	

Pattern of bladder wall abnormalities among infected subjects

Analyzing the bladder wall pathologies one by one, 9/17 (53.0%) of infected pupils had thickening of the bladder wall, 5/17 (29.4%) had bladder wall irregularities, and 3/17 (17.6%) had bladder wall masses (See **Table 4**). These abnormalities altered the rectangular shape of the bladder wall in 10/17 (58.8%) of them (See **Figure 1**).

All the uninfected controls with bladder wall abnormalities, had only bladder wall irregularities.

Table 4. Pattern of bladder wall abnormalities among infected subjects.

Parameter		Frequency (N = 17)	Percentage (%)
Bladder wall irregularity	Multifocal irregularity	3	17.6
	Focal irregularity	2	11.8
Bladder wall thickness	Multifocal thickness	7	41.2
	Focal thickness	2	11.8
Bladder wall masses	Multiple masses	0	0.0
	Single mass	3	17.6

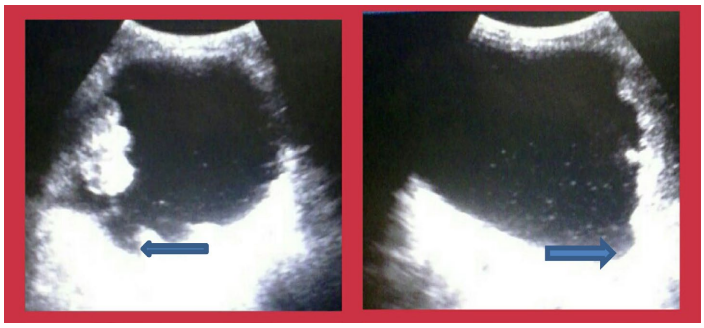

Figure 1. Ultrasound pictures of bladder masses and irregularity of the bladder walls in an infected subject.

4. Discussion

The overall prevalence of urinary tract pathology among infected pupils in this study was 77.3%. Similar to this finding, Nmorsi *et al*., [7] in Edo State and Sacko *et al*. [11] in Carriere community in Mali, reported UTP prevalence rates of 73.3% and 62.2% respectively [7] [11]. Similar to this index study where majority of them were found not to have received praziquantel for over a year before the study (despite the on-going control program), majority of the subjects with UTP in the latter studies [7] [11], did not receive medication for schistosomiasis at the time of the study. This may account for the similarities with the studies. The high prevalence in this study contrasts with that of Ekwunife *et al*. [8] from a neighboring state (Anambra) in Nigeria, who reported an overall prevalence of 38.3% among subjects. Regular use of anti-schistosomal treatment could be a factor as the subjects in the latter study [8] were visiting the hospitals regularly for treatment of urinary schistosomiasis, even at the time of the study, unlike in this present study.

This treatment could have halted or reversed the development of UTP in those subjects, reducing the overall prevalence of the UTP [8].

The majority of the infected subjects in this study had bladder wall pathology. This is comparable to the studies by Nmorsi *et al*., [7] Sacko *et al*., [11] and Brouwer *et al*. [12] in different parts of Africa, who recorded bladder pathology in the majority of their subjects [7] [11] [12]. The similarity could be due to the fact that, like the index study, subjects in the later studies were also not on praziquantel. This could also be supported by the observation that Ekwunife *et al*. [8] documented a lower prevalence of 38.3% among their study participants who were on regular praziquantel.

The prevalence of hydroureter in this study was 9.1%. Nmorsi *et al*. [7] and Vester *et al*. [13] reported hydroureter prevalence of 23.3% and 23.0% respectively [7] [13]. The low prevalence could be due to mild infection documented in the majority of the infected subjects in the index study, where those who had > 100 eggs/10mls of urine were just 4.5% whereas Vester *et al*. [13] documented 13% in his study. This could account for the much lower prevalence of hydroureter in the index study as UTP has been shown to correlate positively with egg output (intensity of infection) [8] [11] [13]. Nmorsi *et al*. [8] studied both children and adults, unlike the present study that studied only children and this can explain the difference in the prevalence since UTP has been shown to be commoner among infected adults [14]. Barda *et al*. [15] reported a lower prevalence of hydroureter of 4% among infected school-aged children. This may be accounted for by a higher proportion of their subjects (70.0%) with mild infection compared to this index study (63.6%).

The prevalence of hydronephrosis among infected subjects in this study was 40.9%. Comparable to this finding, Brouwer *et al*. [12] in Zimbabwe reported hydronephrosis to be present among 36.0% of infected children [12]. The prevalence of hydronephrosis in this study is, however, higher than those reported by Ekwunife *et al*. [8], Nmorsi *et al*. [7], and Sacko *et al*. [11], which were 8.3%, 18.6% and 19.4% respectively [7] [8] [11]. The lower prevalence documented by Ekwunife *et al*. [8], in contrast to this study, can be explained by the availability of treatment, which could have reversed or halted the progression of the complication [8]. Variations in how different hosts' immunity reacts to infection and the antigenicity of different strains of the parasites from different ethnicities could be a factor for the higher prevalence in this study, different from the lower prevalence as documented by Nmorsi *et al*. [7] and Sacko *et al*. [11].

A finding that is worthy of note in this study is that the prevalence of hydroureter was much lower than that of hydronephrosis among infected subjects. Some radiologists have argued that ureteral fibrosis, calcification and dysfunction after dilatation, may not be apparent with ultrasonography but are likely to be apparent with Intravenous Urography (IVU) [16]. Abdel-Wahab *et al*. [17] reported ultrasound to have low sensitivity (62.5%) in detecting hydroureter compared to Intravenous Urography. Oluwafemi *et al*. [18] reported a case of

hydroureter from urinary schistosomiasis, using IVU, which was not detected using ultrasonography. This may also be the reason why several studies [7] [8] [19] [20], did not report any hydroureter. In contrast, Vester *et al*. [13] and Elmadani *et al*. [21] reported a higher prevalence of hydroureter, compared to hydronephrosis; different from this index study, perhaps due to the different method of classification of UTP in their studies [13] [21].

UTP in this study had no gender preponderance, perhaps due to the almost equal prevalence and intensity of infection in males and females. This UTP finding is, however, at variance with the male preponderance documented by other studies [8] [19] and attributed to the different exposure rates; as males had higher exposures (due to their longer length of stay inside water, they could have acquired more worm burden and its attendant pathological lesions) in those studies [8] [19], different from the index study. Onile *et al*. [20] reported a higher incidence of UTP among females, probably because they studied predominantly females (69.3%) [20], different from this study that had equal representation of both males and females.

The prevalence of bladder wall pathology among infected subjects in the index study showed no age predilection, but this is not surprising because age did not significantly affect the intensity of the infection in the index study. Some other studies [8] [13] [14] reported association between age and UTP. It is, however, worthy to note that the highest prevalence of bladder pathologies was documented among the age groups with the highest intensity of urinary schistosomiasis in the above studies [8] [13] [14]. Intensity of infection has been shown to correlate positively with the prevalence of UTP of urinary schistosomiasis in many studies [7] [19] [21].

Abnormal shape, thickening, and irregularity of the bladder wall were the most common bladder pathological lesions identified in this study. Similar findings have been reported in some studies [7] [20] [21]. The reason for the above may be due to granulomatous formations, which increase the thickness of the bladder wall, alters its shape, and its contour.

5. Conclusion

A high prevalence of UTP was noted among infected subjects in this study, and this is a major health concern. Bladder wall pathology, hydroureter and hydronephrosis were the three UTP found in infected subjects, and they are risk factors for chronic kidney disease if no intervention is instituted early. The prevalence of UTP was significantly higher among infected compared to uninfected subjects in this study, further supporting the fact that UTP noted from this study may most likely be from urinary schistosomiasis.

Limitation of the Study

Combination of ultrasonography with IVU or other imaging techniques would provide a more comprehensive assessment of UTP in future studies.

Acknowledgements

We wish to acknowledge the research assistants who made this work a success. We appreciate the assistance of the school authorities and parents.

Conflicts of Interest

The authors declare no conflicts of interest.

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