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Bacteriuria Co-Infection in Urinary Schistosomiasis Among Vulnerable Children in Safana District of Katsina State-Nigeria

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ABSTRACT

Background and Objective: Urinary schistosomiasis is one of the most significant neglected tropical diseases that constitutes a serious public health challenge globally. The burden of urinary schistosomiasis is further worsened by co-infection with bacterial Urinary Tract Infections (UTIs). This study aimed at assessing bacterial co-infection in urinary schistosomiasis among vulnerable children (Almajiris) in Safana Town, Katsina State, Nigeria. **Materials and Methods:** A total of 277 mid-stream urine samples were collected in sterile, screw-capped universal bottles using stratified random sampling technique and analyzed for the presence of the eggs of *Schistosoma haematobium* and bacterial strains using centrifugation, microscopy and bacterial culture techniques, respectively. **Results:** From the 277 urine samples analyzed in this study, the eggs of *Schistosoma haematobium* were detected in 30.32% (84/277) of the samples, the age groups 6-10 years and 11-15 years had the highest frequencies of occurrence of urinary schistosomiasis in this study and the lowest frequency of occurrence was observed in the age groups 1-5 years respectively. A total of 53.57% (45/84) bacterial strains were recovered from urine samples positive for *Schistosoma haematobium*. *Staphylococcus aureus* 37.14% (13/45) had the highest frequency of occurrence and *Klebsiella* sp., 5.71% (2/45) had the least frequency of occurrence in this study. **Conclusion:** Bacterial co-infection with Urinary schistosomiasis in vulnerable children is underreported in the study area. Further research on the antibiogram of bacterial isolates is urgently needed to improve the management and outcome of patients.

KEYWORDS

Almajiris, bilharziasis, *schistosoma haematobium*, Neglected Tropical Diseases (NTDs), disease of poverty, bacterial urinary tract infections, mass chemotherapy

INTRODUCTION

Urinary schistosomiasis (Bilharziasis) is one of the most significant Neglected Tropical Diseases (NTDs) and a major parasitic disease that constitutes a serious public health challenge globally. Bilharziasis is caused by a blood fluke (trematode) of the genus *Schistosoma*. The flatworm invades the venous plexus of the bladder and causes a wide range of conditions, which include haematuria, painful urination, anemia, an enlarged liver and the risk of liver fibrosis, infertility, and the etiology of bladder cancer[1,2].

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Schistosomiasis is caused by several species of *Schistosoma*. However, *Schistosoma haematobium* is the most common etiologic agent for urinary schistosomiasis and *Bulinus* species are the intermediate hosts for *S. haematobium*[3].

It is the second most common parasitic disease after malaria, with an estimated 300,000 deaths annually in Africa. The World Health Organization (WHO) estimated that about 236.6 million people required prophylaxis treatment in 2019[1,4]. The disease has been reported to be endemic in 78 countries, where the transmission rate is high, but, with mass preventive chemotherapy, there remain 51 endemic countries with moderate-to-high transmission rates that require mass chemotherapy. The most affected countries are the low-and-low-middle-income countries in Sub-Saharan Africa, which account for nearly 90% of all cases globally[4]. Several studies have reported Nigeria to be the most endemic country in the world for schistosomiasis, which is widely spread in rural areas, mainly in riverine communities and around dams[5-7]. The burden of urinary schistosomiasis is further worsened by co-infections with bacterial Urinary Tract Infections (UTIs). Urinary tract infections occur due to the presence of pathogenic bacteria in urine with more than 10^5 colony-forming units mL^{-1}. Urinary schistosomiasis co-infection with other pathogenic microorganisms can worsen the symptoms and complications caused by the parasite, especially in patients with weakened immune systems, thus, increasing the risk of complications such as kidney failure and obstruction of the urinary tract[8]. Patients with bacterial co-infections may experience complications because the normal microbiome found in the urinary tract can easily enter and invade the tissues beneath via the weared-off epithelial lining of the urinary tract by the spiny ova of the parasite inducing the release of Interleukin-4 (IL-4) and eventually worsening the health outcomes of individuals with urinary schistosomiasis. As a result, this primary factor of the parasite has been hypothesized to be attributable to an increased risk of bacterial co-infections[9,10] and may lead to various clinical complications[9,11].

Urinary schistosomiasis and bacterial urinary tract co-infections are very common among children in the tropics. The incidence of UTIs in children is greatly influenced by age and sex, as well as the immunological factors that promote a healthy urinary tract[12]. Although urinary schistosomiasis infection is widespread in Nigeria and has been reported to be hyper-endemic in numerous northern states, including Katsina, among others, there is a shortage of data on co-infection of UTIs in urinary schistosomiasis in Katsina State[13-15]. Therefore, this study was aimed at evaluating the occurrence of UTIs in urinary schistosomiasis among vulnerable children (Almajiris) in Safana Town in Katsina State, Nigeria.

MATERIALS AND METHODS

Description of the study locations: The study was conducted from April to June 2022 among the vulnerable children (Almajiris) in 3 selected schools in Safana (12°24'30"N, 7°24'25"E), a town in Safana Local Government Area of Katsina State, Nigeria. The people of the communities are predominantly farmers and rural traders. Although many of the community dwellers have access to portable sources of drinking water, boreholes and wells, some use streams and ponds as sources of water for recreational, agricultural and domestic activities.

Ethics statement and informed consent: Ethical approval to carry out this study was obtained from the ethical review committee of the Katsina State, Ministry of Health with approval number: MOH/ADM/SUB/1152/1/556. Informed consent forms were administered to the children and consent was obtained in verbal forms.

Sampling communities: Three Almajiri schools were selected using a stratified random sampling technique. Structured questionnaires were used for collecting data at the point of sample collection. The 3 schools sampled are, Mallam Ishaq, Mallam Audu and Mallam Shuaibu Schools in Safana Town, respectively.

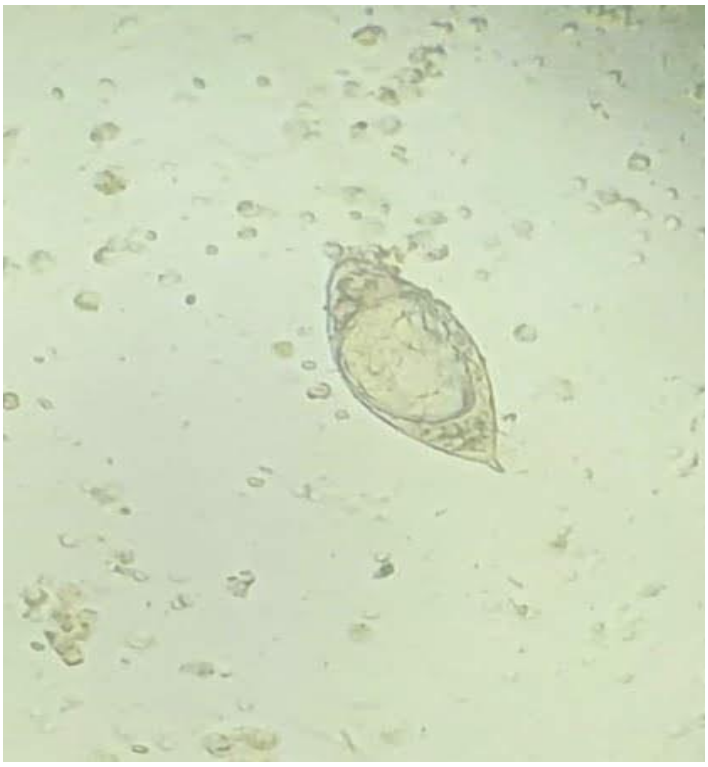

Fig. 1: Ova of *Schistosoma haematobium* showing terminal spine ×400

Collection and transportation of urine samples: A total of 277 mid-stream urine samples were collected in sterile, screw-capped, well-labeled universal bottles between 10:00 a.m. and 2:00 p.m. The students were grouped into 4 age groups, A = 1-5 years, B = 6-10 years, C = 11-15 years and D = 16-20 years. The samples collected were transported to the Microbiology Laboratory, Federal University Dutsin-Ma in an ice-packed cold box (away from sunlight) to prevent the ova from hatching before urine analyses.

Microscopical examination of urine samples: Each urine sample was thoroughly mixed to re-suspend deposits, 10 mL of the sample was transferred into a clean centrifuge tube and centrifuged at 2000 rpm for 3 min. The supernatant was decanted and the tip of the tube was gently tapped to mix the urine deposits. A clean plastic pipette was used to transfer a drop of the mixed urine deposit onto a clean grease-free glass slide and covered with a cover slip. The slide was then examined under a binocular microscope (Motic™ 2820 LED cordless Wetzlar, Germany), using the ×10 objective lens to detect and count the ova of *Schistosoma haematobium* and the ×40 objective lens was used to confirm the position of the terminal spine with sufficiently closed iris diaphragm to give a good contrast[16] (Fig. 1).

Isolation and identification of bacteria in urine samples: Urine samples positive for the ova of schistosoma *haematobium* were inoculated on Mannitol Salt Agar, MacConkey Agar and Eosin Methylene Blue Agar plates, respectively and incubated at 37°C for 24 hrs. Preliminary identification of bacterial isolates was carried out based on the isolate's colonial characteristics and Gram's staining reaction. Thereafter biochemical characterization of isolates was carried out, the biochemical tests that include: mannitol fermentation, lactose fermentation, catalase Test, slide coagulase Test, oxidase, indole, methyl red, Voges Proskauer, citrate utilization, blood haemolysis and triple sugar iron Tests, respectively[17].

Statistical Analysis: The generated data sets were analyzed using descriptive statistics with the IBM SPSS package (Illinois, USA) at a 95% confidence interval with a 0.05 (p) level of significance.

RESULTS

Eggs of *Schistosoma haematobium* were detected in 30.32% (84/277) of the urine samples analyzed as shown in Table 1. The age groups 6-10 years (B) and 11-15 years (C) had the highest frequencies of occurrence of urinary schistosomiasis in this study than other age groups (A and D) (Fig. 2). Bacteria were recovered from 53.57% (45/84) of the samples positive for *Schistosoma haematobium* (Table 2). The bacterial strains isolated include, *Staphylococcus aureus* 37.14% (13/45), *Escherichia coli* 28.57% (10/45), *Klebsiella* sp., 5.71% (2/45) and mixed growth 28.57% (10/45) (Fig. 3).

Table 1: Prevalence of urinary schistosomiasis infection among vulnerable children in Safana Town

School	Number of samples collected	Number positive for *S. haematobium*	Percentage infected
Mallam Ishaq	130	43	33.07
Mallam Audu	74	21	28.37
Mallam Shuaibu	73	30	41.09
Total	277	84	30.32

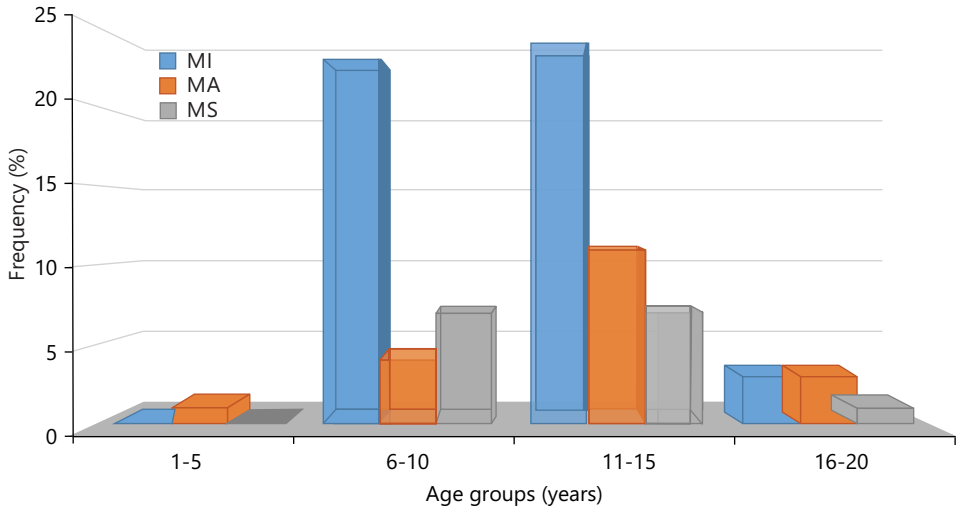

Fig. 2: Frequency of occurrence of urinary schistosomiasis among age groups in the study area
MI: Mallam Ishaq School, MA: Mallam Audu School and MS: Mallam Shuaibu School

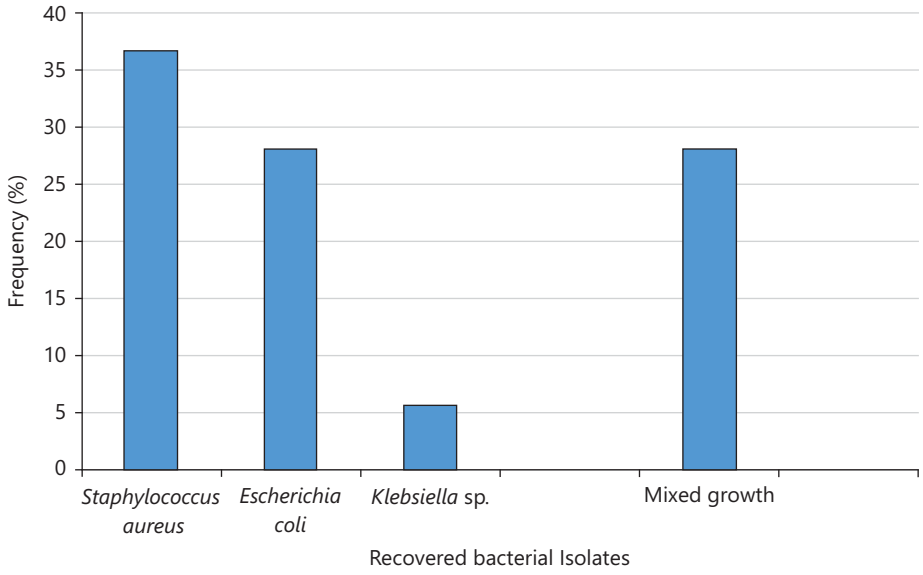

Fig. 3: Percentage frequency of bacterial strains recovered from urine samples positive for *Schistosoma haematobium*

Table 2: Frequency of occurrence of bacteriuria in urine samples positive for *S. haematobium*

School	Number positive for *S. haematobium*	Number of samples co-infected with bacteria	Percentage infected
Mallam Ishaq	43	20	46.51
Mallam Audu	21	12	57.14
Mallam Shuaibu	30	13	43.33
Total	84	45	53.57

DISCUSSION

The current study results showed that the eggs of *Schistosoma haematobium* were present in 30.32% (84/277) of the samples analyzed, which was below the World Health Organization (WHO) hyper-infection prevalence threshold of 50% for school-age children (Table 1)[18].

The moderate prevalence rate of urinary schistosomiasis in this study may be attributable to occupational activities such as irrigation and fishing, recreational activities like swimming and domestic activities such as washing and bathing in contaminated water. The age groups 6-10 years and 11-15 years had the highest frequencies of occurrence of urinary schistosomiasis in this study and the lowest frequency of occurrence was observed in the age groups 1-5 years, respectively (Fig. 2).

This was in consonance with previously reported studies conducted within Katsina State[14-19] and the southern region of Nigeria, where the prevalence rates of urinary schistosomiasis were reported as 39% in Enugu, 38% and 23.77% in Ipogun and parts of Ondo State, respectively[2,11,20]. Several scientific literatures have reported that urinary schistosomiasis is still endemic in Nigeria[21,22]. Although, several studies have previously been conducted to assess the prevalence of urinary schistosomiasis in Katsina state, there is limited data on bacterial co-infection in urinary schistosomiasis among vulnerable children in the study locality[15,19].

Bacterial strains were recovered from 53.57% (45/84) of the urine samples positive for *Schistosoma haematobium* in the study (Table 2). *Staphylococcus aureus*, *Escherichia coli* and *Klebsiella* sp., were the predominant bacteria isolated. All of the bacteria genera recovered in this study have been previously reported to be isolated from urine samples[2,23]. *Staphylococcus aureus* had the highest frequency of occurrence at 37.14% (13/45). This study agreed with previously reported findings[2,23,24]. Furthermore, *Escherichia coli* had a frequency of occurrence of *28.57*% (10/45). *Escherichia coli* has been previously reported as the predominant bacterial strain recovered in urine samples positive for *S. haematobium*[25]. *Klebsiella* sp., had the least frequency of occurrence at 5.71% (2/45) of the bacteria isolated in this study. This highlights the need for improved hygiene practices in vulnerable children to prevent the spread of bacterial UTIs.

Bacterial co-infection in urinary schistosomiasis has been reported to increase the risk of developing kidney infections and can cause a wide range of health conditions[1,2]. The condition has also been reported to reduce the efficacy of antimicrobial agents as a result of the antimicrobial agent sequestration within the parasite, which often leads to an inability to completely eradicate the bacteria by antimicrobial agents. It is also reported that antibiotic treatment was usually unsuccessful and persistent bacterial infections may result in the development of antimicrobial resistance[26]. The study highlights the prevalence of bacterial co-infections in patients with urinary schistosomiasis, which has important clinical implications for the management of these patients. The identification of the predominant bacterial strains causing UTIs in this population can help guide empirical antibiotic therapy and inform future research efforts, antimicrobial stewardship and the judicious use of antibiotics. The findings from this study can be applied in the clinical management of patients with urinary schistosomiasis and co-existing UTIs and can inform the development of diagnostic tests and treatment protocols tailored to this vulnerable population with urinary schistosomiasis and UTIs. The study highlights the need for improved diagnostics and treatment options for patients with urinary schistosomiasis and public health interventions aimed at improving

hygiene practices in vulnerable populations. The intervention should be implemented and evaluated for effectiveness. The study was limited by its small sample size and single-center design, which may limit the generalizability of the findings. Further research is needed to investigate the antibiotic susceptibility profiles and mechanisms that may underlie antimicrobial resistance in the studied population and develop effective strategies to address the issue.

CONCLUSION

The association of bacteriuria with urinary schistosomiasis in vulnerable children is worrisome amidst the global burden of schistosomiasis. Bacterial co-infection with urinary schistosomiasis has been underreported and portends a public health threat in the study area. Clinicians and healthcare practitioners should step up the management of urinary schistosomiasis with adequate diagnostic methods, appropriate antibiotics or antifungal therapy may be required to manage the co-infections and prevent further complications. Mass chemotherapy of vulnerable children should be sustained to eradicate the parasite and its potential impact on the clinical course and patients' outcomes.

SIGNIFICANCE STATEMENT

The co-infection of bacterial urinary tract infections (UTIs) with urinary schistosomiasis in vulnerable children is a serious public health concern in Safana Town, Katsina State, Nigeria. The findings of this study underscore the need for clinicians and healthcare practitioners to adopt appropriate diagnostic methods and antimicrobial and antifungal regimens in the management of urinary schistosomiasis co-infections with bacterial UTIs. Additionally, the mass chemotherapy of vulneable children should be sustained to eradicate the parasite and prevent its transmission.

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