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Asymptomatic Bacteriuria Prevalence among Primary School Children in the Federal University of Technology, Akure (Futa), Ondo State, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

A study was carried out to determine the prevalence of bacteriuria among primary school children in The Federal University of Technology, Akure. One hundred and fifty (150) Mid-Stream Urine (MSU) samples were collected from both male and female pupils aged 5-11. Samples were examined macroscopically for colour and haematuria prior to the microbiological analysis on Cystine Lactose Electrolyte Deficient (CLED) agar using standard methods. Macroscopic examination showed 50.67% of urine samples with amber and clear; 14.67% with amber and cloudy, 6% with straw and cloudy and 24% with straw and clear. 2.67% of samples showed haematuria. Bacteria isolates encountered are *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella* spp., and *Pseudomonas aeruginosa*. The predominant bacterial isolate was *E. coli* (56.8%), followed by *S. aureus* (18.9%), *Klebsiella* spp. (16.2%) and *P. aeruginosa* (8.1%). Overall prevalence of bacteriuria was 24.7%. Bacteriuria was higher among females (29.9%) than in males (11%). School children within the age group 10-11 yrs had the highest prevalence (20.0%), and in males; while age group 5-7 yrs had the highest asymptomatic bacteriuria prevalence (35.3%) and in females. This paper discussed the possible health implications of bacteriuria prevalence observed, and also emphasized the need for routine laboratory checks among children in the primary school.

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1. INTRODUCTION

Bacteriuria is defined as the presence of significant bacterial count in urine. It usually precedes symptomatic urinary tract infection, which is characterized by dysuria, frequency in urination, pain, and fever [1]. Urinary tract infection (UTI) is any infection of a part of the urinary tract [2]. UTIs are among the most common bacterial infections in human, community and hospital settings. It occurs in all age groups, genders, and usually requires urgent treatment [3]. Bacteriuria can be symptomatic or asymptomatic, but UTI involves clinical signs and symptoms [1]. Asymptomatic bacteriuria (AB) or urinary tract infection is defined as isolation of a specified quantitative count of bacteria in an appropriately collected urine specimen from an individual without symptoms or signs of urinary tract infection. AB is common with varying prevalence by age, sex, sexual activity and the presence of genito-urinary abnormalities. Women with AB are more likely to experience symptomatic UTI than those without AB. *Escherichia coli* is the most frequent microorganism isolated from subjects with asymptomatic bacteriuria [4]. *E. coli* remains the single most common microorganism isolated from women, but other organisms, such as *Proteus mirabilis,* are more common in men [2].

In a Swedish study, it was found that during infancy the prevalence of asymptomatic bacteriuria was higher among boys (2.5%) than girls (0.9%), because boys have structural abnormalities of the urinary tract more frequently than girls [5]. After infancy, the prevalence of asymptomatic bacteriuria was much higher among girls (1% to 2%) than among boys (<0.1%). Asymptomatic bacteriuria develops into systematic urinary tract infections in fewer than 10% of cases. In children, asymptomatic bacteriuria may be a sign of underlying urinary tract abnormalities. Also, the study conducted by Jha and Singh [5] in Pokhara valley showed the incidence rate of asymptomatic bacteriuria in children from age 5 to 13 years to be 1.39%. After 15 years of follow-up, symptomatic urinary infection and pyelonephritis occurred at least once in 55% and 7.5% of women with bacteriuria at enrollment respectively, and in 10% and 0% of those without bacteriuria [2].

According to an article in the Urologic Nursing Journal (Overview of the Evaluation, Diagnosis, and Management of Urinary Tract Infections in Infants and Children), the preschool and school age children prevalence of UTI is about 1% to 5% for females and is rare in males [6]. Whereas in the Campbell-Walsh urology the incidence of UTI in school-age children was 0.03% to 1.2% for boys and it rises to 1% to 3% for girls [7]. Following puberty the incidence increases for females and remains uncommon for males. During adolescence, the incidence of UTI significantly increases (to 20%) in young women, while remaining constant in young men. In girls the rates of UTI declines after the age of 6 and rises again significantly in adolescence due to increase in sexual activity [8]. In another study conducted in Tunisia on a group of children aged between 2 months and 14 years with a mean age of 5 years, the frequency of UTI was found to be 1.85% [9]. The incidence of UTI was high in the first 6 months and more in boys than in girls (3% of girls and 1% of boys suffer from UTI in the first ten years of their life) [10].

UTI in children are a significant source of morbidity, particularly when associated with renal abnormalities. AB can predispose to serious morbidity and mortality in children when not detected and treated; and recurrent UTI if untreated, thus necessitating periodic reviews [11,12,13]. However, since asymptomatic colonization of the urinary tract can occur, other features such as the presence of inflammatory markers or follow-up cultures may be needed to definitively diagnose a UTI [14]. In general, bacteria infect the urinary tract by ascending from the urethra, although haematogenous infection may occur in rare instances among young infants [15].

Children generally have a low rate of symptomatic UTI, except that the prevalence of bacteriuria among girls has been found to be higher compared to that in boys [11]. The nature of female urethra is of much practical significance and is one of the reasons why UTI is more common in renal damage and end stage renal failure in a significant number of female patients. It is therefore imperative to diagnose UTI early enough and treat it appropriately so as not to result in chronically ill health and long term renal damage [16]. The incidence of UTI varies in early infancy and childhood, being more common in boys in the first three months of life, with reported distribution of 5:1 with male

predominance, whereas in later childhood, the reported male to female ratio is 1:10 [17].

Bacteriuria is regarded to be significant when the urine contains 10^5 organisms or more per millilitre in pure culture [13]. Infection of the bladder is called cystitis. The risk of infection is increased when there is urine retention due to the bladder not emptying completely, or when urinary flow is obstructed due to renal stones, urinary schistosomiasis, enlarged prostate (the most common causes of recurring UTI in men), or tumor and persistent or recurrent UTI can lead to renal failure [18].

At this juncture, it is opined that the awareness on the possible risk to health of asymptomatic bacteriuria cannot be overemphasized. Researchers have shown that prevalence of bacteriuria in children vary with location, and often with a higher prevalence in girls when compared to boys. Hence, the present study hoped to add to the body of data on bacteriuria prevalence. It is therefore aimed at determining the prevalence of bacteriuria among apparently healthy primary school children in the Federal University of Technology, Akure (FUTA) staff primary school located in Akure-South LGA of Ondo State, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Site

Akure, the capital of Ondo State, is located in the south-western part of Nigeria. It has a population of 387,100. For this research, the Federal University of Technology, Akure (FUTA) staff primary school was the study site. It is located at the Obakekere (Mini) campus. It is a mixed school; comprising of both male and female children of primary school age.

2.2 Ethical Consideration

Upon introduction and application, a letter of permission was issued by the school administration through the head mistress to each teacher so that pupils could be addressed in various classes. Only pupils whose parent(s) gave consent volunteered to give out their urine.

2.3 Urine Sample Collection

Urine samples were collected from both male and female primary school pupils (5-11 yrs) according to the method of Oluyemi et al. [19]. A standardized question containing information on age, sex, religion, class, toilet facilities, water facilities, in school premises and home were given out along with the sample bottles, for parents to aid with the filling and collection of samples. Each sample was labelled according to the number on the questionnaire asked from the study subjects. Midstream urine (MSU) samples were collected in a sterile, wide-necked, leak proof universal bottle. The samples were immediately transferred to the Microbiology laboratory for macroscopic examination and microbiological analysis.

2.4 Microbiological Analysis of Urine Samples

The culture medium used was Cystine Lactose Electrolyte Deficient (CLED) agar (Oxoid – CM0301) for differentiation and enumeration of microorganisms in urine. It was prepared according to the manufacturer's instruction (36.2 g in 1 litre of distilled water) and as stated in Cheesbrough [20].

2.4.1 Total viable plate count

Serial dilution was carried out on each urine sample according to Oluyemi et al. [19]. 0.1 ml of the 10^3 dilution was used as inoculum in the pour plating technique. Plating was carried out in triplicates to ensure accuracy and precision. Plates were incubated at 35℃ for 24 hrs. Viable counts were expressed as the colony forming units (cfu) of organisms per ml of urine (cfu/ml).

2.4.2 Examination of culture plates, subculture and identification of bacterial isolates

After incubation, the plates were examined and the appearance of urinary pathogens on the CLED agar plates were observed and recorded. Bacterial colonies on the plates after incubation were purified by subculturing on freshly prepared CLED agar and incubated at 35℃ for 24 hours. Purity was confirmed by Gram staining and pure isolates were characterized and identified using morphological characteristics and biochemical tests according to Fawole and Oso [21] and Bergey's Manual of Systematic Bacteriology [22].

2.5 Data Analysis

Statistical analysis was carried out using Analysis of Variance (ANOVA) at 95%

confidence interval in the SPSS 16 windows version, and Duncan's New Multiple Range Test (DNMRT) was used for separation of means.

3. RESULTS

The macroscopic appearance of all urine samples collected was shown in Table 1. 50.7% were amber and clear, and 2.7% were heamaturic.

Table 2 showed the morphological and biochemical characteristics of bacterial isolates from the urine samples. Bacteria species isolated were *Staphylococcus aureus, Escherichia coli, Klebsiella* spp. and *Pseudomonas aeruginosa.* All the isolates were catalase positive.

In Table 3, the total bacteria count from urine samples of both female and male pupils/school children were shown. The highest count in female pupils was observed in the age group 10-11 yrs, with bacterial count of 12.13 x 10^3 (cfu/ml). The highest bacterial count observed in male pupils was 10.17 x 10^3 (cfu/ml), and was recorded in the 10-11 yrs age group.

Table 4 showed the distribution of bacteriuria among pupils in the study area by age and sex. Eight-seven female pupils were examined for bacteriuria and twenty-six were discovered to be infected. The highest prevalence among male (20.0%) and their female (35.3%) counterparts was found between age group 10-11, and age group 5-7 respectively, while the lowest prevalence between male (16.0%) and female (22.2%) was found between age group 5-7, and age group 8-9 respectively.

Table 5 showed the prevalence of bacteria isolated from the urine samples for both male and female FUTA staff school pupils. *E. coli* was the most prevalent microorganism with a total number of samples infected recorded as 21 (56.8% prevalence).

Table 1. Macroscopic appearance of all urine samples among the pupils

Macroscopy	Female	Male	Total	Total % of appearance
Amber and clear	47	29	76	50.7
Amber and cloudy	8	14	22	14.7
Straw and cloudy	8	1	9	6.0
Straw and clear	21	15	36	24.0
Straw with particles	1	2	3	2.0
Heamaturia	2	2	4	2.7
Total	87	63	150	100

Table 2. Morphological and biochemical characteristics of urine isolates

Isolates	Colour	Gram Rxn	Shape	Motility	Indole	Citrate	Urease	Oxidase	Catalase	Lactose
Escherichia coli	Deep yellow	-ve	R	+	+	-	-	-	+	+
Staphylococcus aureus	Tiny whitish	+ve	C	-	-	-	-	-	+	-
Pseudomonas aeruginosa	Greenish	-ve	R	-	-	+	+	+	+	-
Klebsiella spp.	Pale yellow	-ve	R	-	-	+	+	-	+	+

Key: *Rxn= reaction, +ve = positive, -ve = negative; R= rod, C= cocci*

Table 3. Total bacterial count (cfu/ml) range by age and sex

Age group (Yrs)	Bacterial load (cfu/ml x10^3)	
	Male	Female
5-7	2.10±0.12 – 3.23±0.33[a]	1.20±0.66 – 5.25±0.58[a]
8-9	2.23±0.58 – 6.00±0.33[b]	3.00±0.58 – 7.00±0.33[b]
10-11	5.23±0.23 – 10.17±0.33[c]	5.21±0.33 – 12.13±0.88[c]

a, b, c = Values followed by different alphabet superscript along the same column are significantly different at P<0.05

Table 4. Prevalence of bacteriuria in the urine samples

Age group (Yrs)	Male			Female			Total number examined	Total number infected	% infected
	Number examined	Number infected	% infected	Number examined	Number infected	% infected			
5-7	25	4	16.0	34	12	35.3	59	16	27.1
8-9	18	3	16.7	27	6	22.2	45	9	20.0
10-11	20	4	20.0	26	8	30.8	46	12	26.1
Total	63	11	17.5	87	26	29.9	150	37	24.7

Table 5. Overall prevalence of bacterial isolates from the urine samples

Bacterial Isolate	Male	Female	Total infected	Total prevalence (%)
	No. infected	No. infected		
Staphylococcus aureus	1	6	7	18.9
Escherichia coli	6	15	21	56.8
Klebsiella spp.	1	5	6	16.2
Pseudomonas aeruginosa	3	0	3	8.1
Total	11	26	37	100

Key: *No. = Number of urine samples*

4. DISCUSSION

UTIs may present with signs and symptoms that are not specific, particularly in infants and young children. Also, in children with urinary tract anomalies, urinary tract infections could be the first sign. Failure to identify persons at risk could result in damage to the upper urinary tract. In this study, the isolation and identification of bacteria in Mid-Stream Urine (MSU) samples were conducted to determine the prevalence of asymptomatic bacteriuria among primary school pupils in Federal University of Technology Akure, Nigeria.

In this study, while noting that macroscopic appearance of urine samples can serve as good screening test for presence or absence of a Urinary Tract Infection (UTI), Yauba et al. [23] opined that urine macroscopy, as well as pyuric symptoms are not very specific for diagnosis. They could however be very sensitive, and serve as indicators to necessitate more tests which need to be done for the diagnosis of a UTI. Out of the 150 urine samples examined, bacteriuria was observed in thirty-seven samples (24.7%). In this study *Escherichia coli* was the most prevalent (56.8%), while Yauba et al. [23] and Onanuga and Selekere [24] recorded a 50% and 52% predominant occurrence for *E. coli* respectively. Jha and Singh [5], Oluyemi et al. [19], and Motamedifar et al. [13] had also put forward similar observations. In their research, all authors reported *Escherichia coli* as the most commonly isolated microorganism when studying the prevalence of asymptomatic bacteriuria among school going children. *E. coli* was however reported by Elo-Ilo et al. [25] as being responsible for only 15.6% of cases studied. It was also observed that *Escherichia coli* was the most frequently isolated microorganism in female than in male [6,24]. This also agreed with the findings of Nicolle et al. [2], who reported *E. coli* to be less frequently isolated in men than women. The prevalence of this member of the Enterobacteriaceae family may be attributed to the anatomy of both sexes. The female urethra is shorter, more exposed and closer to the vulva, compared to the length of the urethra in males. In several researches carried out by Ade-Ojo et al. [26], Ossai et al. [27], Ojide et al. [12], Sujatha and Nawani [28], and Jayachandran et al. [29], *E. coli* was also reported as the most frequently encountered and implicated microorganism associated with asymptomatic bacteriuria, and across varying age groups.

Iduoriyekemwen et al. [30] had earlier reported *Staphylococcus aureus* as more prevalent than *E. coli*. In contradiction, *S. aureus* was the most prevalent microorganism in the study of Elo-Ilo et al. [25], where bacteriuria prevalence among preschool children was assessed. Prevalence of asymptomatic bacteriuria was also significantly higher in females than in males. In their study, samples were collected from children with mean age of 4±0.7 yrs of age. In this study, this microorganism was more isolated in female pupils than male. This is in accordance with the findings of Alo et al. [31] who reported *S. aureus* to be the more prominent microorganism in females than males. This may have been as a

result of infection of the anterior urinary tract or possible human contamination [19]. *S. aureus* is present on the human skin and the environment, so it can serve as a good indicator of hygiene during sample collection, handling and investigation. Some of the pupils were also likely to contaminate their sample with staphylococci directly with their hands when having a nasal discharge. The risk is always increased when pupils have respiratory infections causing sneezing and coughing [19].

Klebsiella spp. is the third most prevalent microorganism (16.2%) with a total of 6 colonies in pure culture. Kumar et al. [32] reported *Klebsiella* spp. as the next microorganism to *Staphylococcus aureus* when studying prevalence of bacteriuria among school going children in India. Sujatha and Nawani [28] however submitted *Klebsiella* spp. as the second most prevalent microorganism associated with asymptomatic bacteriuria, followed by *Enterococcus faecalis*, *S. aureus* and *Proteus mirabilis*. This may be attributed to the difference in age group sampled for the study. Kumar et al. [32] also showed *Klebsiella* spp. to be more prominent in females than in males. This may also be due to the health status of the pupils, as opined in the work of Duel [33], who reported that *Klebsiella* spp. was found among malnourished people.

Pseudomonas aeruginosa was the least frequently isolated microorganism (8.1%), and all were isolated from male children. While *P. aeruginosa* was the least isolated, in the study of Yauba et al. [23], *Salmonella typhi* was recorded as the least frequently isolated microorganism. *P. aeruginosa* has been implicated in aerosol within the environment of collection of the urine sample. Hence, contamination is usually more frequent in environments where sanitary conditions are poor. Method of collecting the urine specimens could have also resulted in sample contamination. As an opportunistic pathogen, *P. aeruginosa* can cause infections and ill-health in immunocompromised persons/patients. All bacteria isolated in this study, with exception of *P. aeruginosa* were more prevalent in females. This gave an impression of low rate of asymptomatic bacteriuria in males. This may be linked to the males being circumcised. Oluyemi et al. [19] had submitted that circumcision of male children aid in reducing high rate of asymptomatic bacteriuria in males. On the other hand, females are more prone to asymptomatic bacteriuria as a result of the position of their urethra.

5. CONCLUSION AND RECOMMENDATION

Asymptomatic bacteriuria (ASB) remains an important problem in primary school children, and was observed in this study to be higher in females than in males. The highest prevalence was observed in age group 5-7 years in females, and 10-11 years in males. *E. coli* was the predominant microorganism, followed by *S. aureus* and *Klebsiella* spp. respectively. *Pseudomonas aeruginosa* was least frequently isolated, and was isolated in male urine specimens only. None of the pupils however showed signs of infection, that is, were asymptomatic. Routine laboratory checkup is essential and very much recommended for children of primary school age in order to prevent unnecessary morbidity and mortality. Early diagnosis would also help to reduce risk of renal scarring and chronic renal insufficiency. Circumcision is also recommended among male children as this could help limit the occurrence of asymptomatic bacteriuria.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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