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Prevalence of symptomatic significant bacteriuria and associated risk factors among patients attending major hospitals in Calabar, Nigeria

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Abstract:

Background: Urinary tract infections (UTIs) are among the most encountered bacterial infections of humans and affect both male and female of all age groups, resulting in high mortality, without proper management. This study aimed to assess the prevalence, aetiological agents, and factors associated with symptomatic significant bacteriuria/UTI among patients attending selected hospitals in Calabar metropolis, Nigeria.
Methodology: This was a cross-sectional study of 240 patients with suspected UTI, from whom mid-stream voided urine samples were collected for culture on Cystine Lactose Electrolyte Deficient (CLED) agar. Uropathogens growth on the culture media were characterized using conventional microbiological and biochemical tests, and confirmed with API® 20E and 20NE (BioMérieux) identification system. Data on socio-demographic, clinical symptoms and potential risk factors were obtained using structured questionnaire. Pearson Chi-square was employed to determine association between categorical variables with $p<0.05$ considered statistically significant.
Results: Of all the urine samples collected from the 240 patients, 13 samples were contaminated during collection, leaving 227 samples for analysis. Sixty-five (28.6%) of the 227 patients had symptomatic significant bacteriuria. Previous history of UTI (OR=2.863, 95% CI=1.582-5.180, p=0.008), contraceptive use (OR=3.469, 95% CI=1.446-8.320, $p=0.012$), pregnancy (OR=9.94, 95% CI=3.867-25.571, $p<0.0001$) and history of urinary catheterization (OR=4.417, 95% CI=1.024-19.053, $p=0.045$) were significantly associated with prevalence of symptomatic significant bacteriuria/UTI. *Klebsiella pneumoniae* (23.1%) was the most predominant isolate, followed by coagulase-negative staphylococci (CoNS) (16.9%) and *Escherichia coli* (12.3%).
Conclusion: The prevalence of symptomatic significant bacteriuria among patients attending selected hospitals in Calabar, Nigeria, was 28.6% (65/227), with *K. pneumoniae* and CoNS being the major aetiologic agents. Our study shows that previous history of UTI, pregnancy, history of urinary catheterization, contraceptive use, dysuria and occupation were significantly associated with symptomatic significant bacteriuria/UTI ($p<0.05$). Routine screening for UTI is recommended for pregnant women, patients with dysuria, previous episodes of UTI, and catheterized patients.

Keywords: Bacteriuria, prevalence, significant, symptomatic, urinary

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Prévalence de la bactériurie symptomatique significative et des facteurs de risque associés chez les patients fréquentant les principaux hôpitaux de Calabar, Nigeria

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Résumé:

Contexte: Les infections des voies urinaires (IVU) font partie des infections bactériennes les plus rencontrées chez l'homme et touchent à la fois les hommes et les femmes de tous les groupes d'âge, entraînant une mortalité élevée, sans prise en charge appropriée. Cette étude visait à évaluer la prévalence, les agents étiologiques et les facteurs associés à une bactériurie/IVU symptomatique significative chez les patients fréquentant des hôpitaux sélectionnés dans la métropole de Calabar, au Nigeria.
Méthodologie: Il s'agissait d'une étude transversale portant sur 240 patients suspectés d'infection urinaire, chez lesquels des échantillons d'urine mictionnés à mi-jet ont été collectés pour être cultivés sur une gélose cystine lactose déficiente en électrolytes (CLED). La croissance des uropathogènes sur les milieux de culture a été caractérisée à l'aide de tests microbiologiques et biochimiques conventionnels, et confirmée par le système d'identification API® 20E et 20NE (BioMérieux). Les données sur les symptômes sociodémographiques, cliniques et les facteurs de risque potentiels ont été obtenues à l'aide d'un questionnaire structuré. Le chi carré de Pearson a été utilisé pour déterminer l'association entre les variables catégorielles avec p<0,05 considéré comme statistiquement significatif.
Résultats: Sur tous les échantillons d'urine prélevés sur les 240 patients, 13 échantillons ont été contaminés lors du prélèvement, laissant 227 échantillons pour analyse. Soixante-cinq (28,6%) des 227 patients présentaient une bactériurie symptomatique significative. Antécédents d'infection urinaire (OR=2,863, IC à 95%=1,582-5,180, p=0,008), utilisation de contraceptifs (OR=3,469, IC à 95%=1,446-8,320, p=0,012), grossesse (OR =9,94, 95% IC=3,867-25,571, p<0,0001) et les antécédents de cathétérisme urinaire (OR=4,417, IC à 95% =1,024-19,053, p=0,045) étaient significativement associés à la prévalence des bactériurie/IVU symptomatique significative. *Klebsiella pneumoniae* (23,1%) était l'isolat le plus prédominant, suivi des staphylocoques à coagulase négative (CoNS) (16,9%) et d'*Escherichia coli* (12,3%).
Conclusion: La prévalence de la bactériurie symptomatique significative parmi les patients fréquentant certains hôpitaux de Calabar, au Nigéria, était de 28,6% (65/227), *K. pneumoniae* et CoNS étant les principaux agents étiologiques. Notre étude montre que les antécédents d'infection urinaire, de grossesse, de cathétérisme urinaire, d'utilisation de contraceptifs, de dysurie et d'occupation professionnelle étaient significativement associés à une bactériurie/IVU symptomatique significative (p<0,05). Le dépistage systématique des infections urinaires est recommandé pour les femmes enceintes, les patients souffrant de dysurie, d'épisodes antérieurs d'infection urinaire et les patients cathétérisés.

Mots clés: Bactériurie, prévalence, significative, symptomatique, urinaire

Introduction:

Urinary tract infection (UTI) is any infection that occurs along the length of the urinary tract. It is characterized by the presence of bacteria in a supposedly sterile urinary tract, resulting in an increased bacterial load (often greater than 10^5/ml) in voided urine sample (1). Urinary tract infections are widespread and affect a large proportion of the human population. Approximately, 150 million people are affected by UTI every year worldwide, with an estimated cost of $5 billion each year in the United States (2).

Although other microbial groups cause UTI, the predominant organisms responsible for UTI are members of the Enterobacteriaceae, with *Escherichia coli* accounting for over 80% of cases (3,4). Among the Gram-positive bacteria, *Staphylococcus aureus* and coagulase-negative staphylococci (CoNS) are mostly implicated in community acquired UTIs. Fungi and viruses rarely cause UTI, however yeast, especially *Candida albicans*, are occasionally recovered from catheterized and/or immunocompromised patients (1). Other bacterial isolates implicated include *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Proteus mirabilis*, *Enterobacter cloacae*, and *Enterococcus faecalis* (2,3).

The risk factors for UTI vary with geographical locations and country. Gender, personal hygiene, prostate problems, compromised immunity, diabetes mellitus, use of spermicidal contraception and urinary catheterization are some of the risk factors for UTI (4). Most cases of UTI are seen in women due to their short urethra, proximity of the rectum to the urethra, change in vaginal pH due to depletion of the commensal bacteria, hormonal imbalance occasioned by menstrual flow and/or pregnancy (5).

Antibiotic resistance among uropathogens is a consistent problem making clinical management of the disease challenging (6) and our previous study showed that this influence the prevalence of UTIs across different geographical areas. Several studies in different sub-Saharan Africa locations show variations in incidence of UTIs as well as the causative organisms (7-10). Mwang'onde and Mchami (4) reported a median prevalence rate of 32.1% in sub-Saharan Africa and the commonest associated causative organism was *E. coli.* Therefore, this current study was conducted to determine the prevalence, aetiological agents and factors associated with bacterial UTIs among patients attending selected hospitals in Calabar metropolis, Cross River State, Nigeria.

Materials and method:

Study setting:

This study was conducted in Calabar, the capital of Cross River State, located in Southern Nigeria. Calabar is administratively divided into Calabar Municipal and Calabar

South Local Government Areas. It is located between latitudes 8°11'21" and 8°27'00" East of the Meridian and between latitudes 04° 45'30" and 05°08'30" North of the Equator. Calabar metropolis has two major rivers: The Great Kwa River and Calabar River.

The city has a total land area of 406 square kilometers (11). According to the 2006 Nigeria Census Report, Calabar Metropolis had a total population of 375,196 (12). However, the rate of urbanization has greatly impacted on the population of the city (11). This population is primarily served by three hospitals; the University of Calabar Teaching Hospital (UCTH), the Nigeria Naval Reference Hospital (NNRH) and General Hospital Calabar (GHC).

Study design:

A descriptive cross-sectional study was conducted between September and December 2021 to determine the prevalence and associated risk factors of bacterial UTIs among patients attending major hospitals in Calabar, Cross River State, Nigeria.

Study participants, sample size and method of sampling:

Both inpatients and outpatients (>5 years) with clinical diagnosis of UTIs were randomly recruited after informed consent was obtained. Patients who had taken antibiotics in the last seven days prior to the day of sample collection, those below 5 years of age, and those who willingly withdrew their consent were excluded from the study. The sample size of 240 was calculated using the Fisher formula with 95% confidence level, 5% precision and 19% prevalence of UTI (7). A total of 240 patients with clinical diagnosis of UTI were enrolled into the study.

Data collection:

Structured questionnaire was used to obtain information on socio-demographic characteristics such as age, gender, educational status, occupation, and marital status. Female patients ≥12 years of age were screened for pregnancy.

Ethical consideration:

Ethical approval for the study was obtained from the Cross River State Health Research Ethics Committee (CRS-HREC) with REC No: CRSMOH/RP/2021/183. Data were collected after an informed, voluntary and oral consent had been secured from each study participant. Confidentiality of subjects' information was ensured. Positive results were reported to attending physician for appropriate treatment and management of the patients.

Urine collection and analysis:

Clean catch mid-stream voided urine specimens were collected into sterile universal containers with each bottle labelled with the patient's identity number and the assigned hospital code. Samples were subsequently transported to the laboratory for microbiological analysis.

Macroscopic and microscopic examinations of urine:

Prior to microscopic examination, each specimen was checked macroscopically for color and transparency and the results recorded. Each sample (5 mL) of urine was centrifuged for 10 minutes at 3000 rpm. The supernatant was examined with 10 x objective lens and then 40 x with the condenser iris closed. Samples with leukocytes ≥ 10 per high power field (40 x objective) were considered to be pyuric (14).

Culture and phenotypic identifications:

Uropathogens were isolated using the semi-quantitative culture technique previously described by Kass (13). Each urine sample was inoculated on Cystine Lactose Electrolyte Deficient (CLED) agar plates using a calibrated loop (0.002 ml) and then incubated aerobically at 37^{o}C for 18-24 hours. Colony forming units (CFUs) were counted to determine significant bacteriuria. Urine samples with colonies ≥ 10^5 CFU/ml were considered significant for bacteriuria.

Distinctive colonies from significant cultures were sub-cultured onto fresh nutrient agar plates. The isolated uropathogens were identified using colonial morphology, growth characteristics, Gram stain reaction, conventional biochemical tests (14), and confirmed with commercial biochemical test kits; Analytical Profile Index (API) 20E and API 20NE (BioMérieux).

Screening for pregnancy:

Pregnancy was screened using a qualitative human chorionic gonadotropin (hCG) urine test (10). In this test, LabACON® (Hangzhou Biotest Biotec Co., Ltd) pregnancy rapid test strip was used to detect hCG hormones in patient's urine samples. The test strip was dipped into a bottle of freshly collected urine and the result read within 3 minutes. For positive result, two lines color bands were observed. For negative result, only one color band was observed.

Statistical analysis:

Data derived from questionnaire and microbiological survey were analyzed using Statistical Package for Social Sciences (SPSS) version 20.0. Descriptive statistics such as frequencies, percentages, means and standard deviations, were derived. Pearson Chi-square was used to determine associations between categorical variables. *P* value of < 0.05 was considered statistically significant.

Results:

Socio-demographic data of participants:

Two hundred and forty participants who met the inclusion criteria were enrolled in the study. Of this, 98 were enrolled from the NNRH, 78 from GHC and 62 from UCTH. Thirteen of the 240 urine samples were contaminated due to inappropriate samples collection measures, and these were excluded from data analysis.

More females (59.5%, 135/227) participated in the study compared to males (40.5%, 92/227). The age of the study participants ranged from 5 to 75 years with the mean age of 34.1±0.8 years (Table 1). About 39.6% (90/227) were in the age group 30-45 years and 49.3% (112/227) were single. Most participants (56.4%, 128/227) had tertiary educational qualification while 44.9% (102/227) of the respondents were students (Table 1).

Table 1: Frequency distribution of socio-demographic characteristics, clinical symptoms and probable risk factors for urinary tract infection among the study participants

Characteristics	Total n (%)	NNRH n (%)	UCTH n (%)	GHC n (%)
Age group (years)				
5-18	15 (6.6)	9 (9.6)	0	6 (8.5)
19-29	82 (36.1)	31 (33.0)	17 (27.4)	34 (47.9)
30-45	90 (39.6)	41 (43.6)	28 (45.2)	21 (29.6)
Above 45	40 (17.6)	13 (13.8)	17 (27.4)	10 (14.1)
Gender				
Male	92 (40.5)	37 (39.4)	29 (46.8)	26 (36.6)
Female	135 (59.5)	57 (60.6)	33 (53.2)	45 (63.4)
Marital status				
Single	112 (49.3)	43 (45.7)	24 (38.7)	45 (63.4)
Married	110 (48.5)	47 (50.0)	37 (59.7)	26 (36.6)
Divorced	3 (1.3)	3 (3.2)	0 (0.0)	0 (0.0)
Widow	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Widower	2 (0.9)	1 (1.1)	1 (1.6)	0 (0.0)
Educational qualification				
No formal education	9 (4.0)	2 (2.1)	5 (8.1)	2 (2.8)
Primary	25 (11.0)	10 (10.6)	8 (12.9)	7 (9.9)
Secondary	65 (28.6)	33 (35.1)	15 (24.2)	17 (23.9)
Tertiary	128 (56.4)	49 (52.1)	34 (54.8)	45 (63.4)
Occupation				
Farming	16 (7.0)	3 (3.2)	9 (14.5)	4 (5.6)
Trading	46 (20.3)	20 (21.3)	15 (24.2)	11 (15.5)
Student	102 (44.9)	38 (40.4)	22 (35.5)	42 (59.2)
Civil servant	56 (24.7)	33 (35.1)	9 (14.5)	14 (19.7)
Artisan	7 (3.1)	0 (0.0)	7 (11.3)	0 (0.0)
Clinical symptoms				
Urine urgency	12 (5.3)	4 (4.3)	6 (9.7)	2 (2.8)
Dysuria	46 (20.3)	17 (18.1)	16 (25.8)	13 (18.3)
Fever	54 (23.8)	25 (26.6)	8 (12.9)	21 (29.6)
Flank or supra-pubic pain	50 (22.0)	23 (24.5)	9 (14.5)	18 (25.4)
Frequency of urination	59 (26.0)	16 (17.0)	25 (40.3)	19 (26.8)
Probable risk factors				
Pregnancy status	22 (16.3)	9 (15.8)	5 (15.2)	8 (17.8)
Use of drug without prescription	63 (15.9)	24 (25.5)	15 (24.2)	24 (33.8)
Previous history of UTI	85 (37.4)	44 (46.8)	18 (29.0)	23 (32.4)
History of catheterization	8 (3.8)	2 (2.1)	5 (8.1)	1 (1.4)
Family history of UTI	121 (53.3)	48 (51.1)	33 (53.2)	42 (59.2)
Diabetes	3 (1.3)	0 (0.0)	2 (3.2)	1 (1.4)
Use of contraceptive	27 (20.0)	7 (12.3)	6 (18.2)	14 (31.1)

NNRH = Nigeria Navy Reference Hospital Calabar; UCTH = University of Calabar Teaching Hospital; GHC = General Hospital Calabar; n = number of participants; % = percentage

Table 2: Association of socio-demographic characteristics of the study participants with symptomatic significant bacteriuria/urinary tract infections

Sociodemographic characteristics	**No of participants with significant bacteriuria/urinary tract infection**				***p* value**
	Total (N=227) n (%)	**NNRH (N=94) n (%)**	**UCTH (N=62) n (%)**	**GHC (N=71) n (%)**	
	65 (28.6)	31 (33.0)	15 (24.2)	19 (26.8)	0.4519
Age group (years)					
5-18 (n=15)	4 (26.6)	4 (44.4)	0	0	
19-29 (n=82)	25 (30.5)	9 (29.0)	4 (23.5)	12 (35.3)	
30-45 (n=90)	24 (26.7)	13 (31.7)	6 (21.4)	5 (23.8)	
Above 45 (n=40)	12 (30.0)	5 (38.5)	5 (29.4)	2 (20.0)	
x^2	.3733	.9605	.3732	3.782	
p value	.9457	.8108	.8298	.2860	
Gender					
Male (n=92)	26 (28.3)	11 (29.7)	11 (37.9)	4 (15.4)	
Female (n=135)	39 (28.9)	20 (35.1)	4 (12.1)	15 (33.3)	
x^2	.01056	.09941	4.284	1.870	
OR (95% CI)	.97 (.54-1.74)	.78 (.32-1.91)	4.43 (1.22-16.05)	.36 (0.11-1.25)	
p value	.9182	.7275	0.0384*	0.1714	
Marital status					
Single (n=112)	27 (24.1)	13 (30.2)	3 (12.5)	11 (24.4)	
Married (n=110)	37 (33.6)	17 (36.2)	12 (32.4)	8 (30.8)	
Divorced (n=3)	1 (33.3)	1 (33.3)	0	0	
Widow (n=0)	0	0	0	0	
Widower (n=2)	0	0	0	0	
x^2	3.305	.8555	3.478	7.153	
p value	.3469	.8361	.1757	0.0280*	
Educational status					
No formal education (n=9)	1 (11.1)	0	1 (20.0)	0	
Primary (n=25)	7 (28.0)	3 (30.0)	3 (37.5)	1 (14.3)	
Secondary (n=65)	22 (33.8)	12 (36.4)	6 (40.0)	4 (23.5)	
Tertiary (n=128)	35 (27.3)	16 (32.7)	5 (14.7)	14 (31.1)	
x^2	2.326	1.198	4.532	1.812	
p value	0.5076	.7536	.2094	.6124	
Occupation					
Farming (n=16)	1 (6.3)	0	1 (11.1)	0	
Trading (n=46)	11 (23.9)	7 (35.0)	2 (13.3)	2 (18.2)	
Student (n=102)	25 (24.5)	11 (28.9)	3 (13.6)	11 (26.2)	
Civil servant (n=56)	23 (41.1)	13 (39.4)	4 (44.4)	6 (42.9)	
Artisan (n=7)	5 (71.4)	0	5 (71.4)	0	
x^2	15.786	2.407	13.670	3.732	
p value	0.0033*	,4923	0.0084*	0.2919	

NNRH = Nigeria Navy Reference Hospital Calabar; UCTH = University of Calabar Teaching Hospital; GHC = General Hospital Calabar; *Statistically significant at $p<.05$; N = Total number of participants with bacteriuria; n = no of participants with significant bacteriuria/urinary tract infection

Clinical symptoms and risk factors of UTI:

Clinical symptoms and risk factors for UTIs observed among the participants are depicted in Table 1. The frequency of clinical symptoms among the study participants were 26.0% (59/227), 23.8% (54/227), 22.0% (50 /227), 20.3% (46/227) and 5.3% (12/ 227) for frequent urination, fever, flank or supra-pubic pains, dysuria and urine urgency, respectively. Of all considered risk factors, 53.3%

(121/227) of the participants had family relatives with history of UTI, 37.4 % (85/227) had recurrent history of UTI, 15.9% (63/227) used drugs without prescription, 3.5% (8/227) had history of urinary catheter, while 1.3% (3 of 227) were diabetic. Out of the 135 female participants, 20.0% (27/135) used contraceptives and 16.3% (22/135) were pregnant (Table 1).

Prevalence of UTI among participants:

Sixty-five out of the 227 urine samples had significant bacterial growth, giving an overall UTI prevalence of 28.6% (Table 2). In NNRH, 31 of the 94 urine samples had significant bacterial growth, giving a UTI prevalence of 33.0%; in UCTH 15 (24.2%) of 62 samples were positive for UTI, and 19 of 71 (26.8%) samples from patients in GHC, had significant bacteriuria (Table 2).

Associated socio-demographic characteristics with UTI:

The prevalence of UTI was slightly higher in females (28.9%, 39/135) than in males (28.3%, 26/92) which was not statistically significant (p=0.918). The prevalence of UTI was also slightly higher among patients in the age group 19-29 years (30.5%) and age >45 years (30.0%) but the difference was not statistically significant (p=0.946). The prevalence of UTI in relation to marital status showed that the prevalence was slightly higher (33.6%, 37/110) among married participants but this was not significantly different from the other marital status (p=0.347).

The prevalence of UTI was highest among patients with secondary educational qualification (33.8%, 22/65) but the difference was also not statistically significant (p= 0.508). With respect to occupational status, artisans had the highest prevalence of UTI (71.4%, 5/7) followed by civil servants (41.1%, 23/56), and these prevalence rates were significantly higher than the prevalence in other occupational groups (p=0.003) (Table 2).

Associated clinical symptoms & risk factors with UTI:

The results revealed that, of all assessed clinical symptoms, only dysuria (OR= 2,065, 95% CI=1.051-4.059, p=0.044) was significant associated with UTI. Pearson Chi-square showed that urine urgency (OR=1.845, 95% CI=0.564-6.039, p=0.3315), fever (OR= 0.5637, 95% CI=0.270-1.177, p=0.1672), flank or supra-pubic pain (OR=0.7388, 95% CI=0.358-1.524, p=0.4808) and frequency of urination (OR=1.260, 95% CI=0.134-1.187, p=0.5055) were not significantly associated with UTI.

Measurement of association between potential risk factors and occurrence of UTI showed that previous history of UTI (OR= 2.863, 95% CI=1.582-5.180, p=0.008), pregnancy (OR=9.94, 95% CI=3.867-25.571, p<0.0001), history of urinary catheterization (OR=4.417, 95% CI=1.024-19.053, p=0.045) and contraceptive use (OR=3.469, 95% CI=1.446-8.320, p=0.012) were significantly associated with occurrence of UTI. However, use of drug without prescription (OR=0.996, 95% CI=0.5234-1.894, p=1.000), family history of UTI (OR=1.227, 95% CI=0.687-2.191, p=0.5568) and diabetes mellitus (OR=5.111, 95% CI=0.455-57.368, p=0.1979) were not significantly associated with the occurrence UTI (Table 3).

Prevalence of uropathogens from the study:

Ten different bacterial species were isolated from the samples of 65 patients with significant bacteriuria/ urinary tract infection. Gram-negative uropathogens constituted 80% (52/65) while 20% (13/65) were Gram-positive cocci. The most predominant bacteria were *Klebsiella pneumoniae* (23.1%), followed by coagulase-negative staphylococci (CoNS) (16.9%), *Escherichia coli* (12.3%), *Enterobacter cloacae* (10.8%), *Citrobacter freundii* (9.2%), *Proteus mirabilis* (7.7%), *Serratia marcescens* (7.7%), *Pseudomonas aeruginosa* (3.1%), *Cronobacter* sp (3.1%), *Enterococcus* sp (3.1%), *Citrobacter koseri* (1.5%) and *Pseudomonas luteola* (1.5%) (Table 4).

Discussion:

In this study, 65 of 227 voided urine samples yielded significant bacterial growths, giving an overall prevalence of 28.6% for symptomatic significant bacteriuria/urinary tract infection among the study participants. This is similar to 31.3% reported from among symptomatic UTI patients in Enugu, Nigeria (16). Outside the shore of Nigeria, Odoki et al., (10) reported 32.2% in Bushenyi District, Uganda, and 29.0% was reported in Ismaila City, Egypt, which are comparable to the present study.

The prevalence of UTI in the present study was slightly higher than the rates previously reported in the same study area (7, 17). Other researchers have also reported UTI prevalence rates higher or slightly lower when compared to the current study (18-20). The observed difference in prevalence of UTI could be attributed to differences in personal hygiene status, study population, socio-economic status, immune status of the study participants and geographical variation. Interestingly, the highest prevalence (33.0%) of UTI was recorded among patients who visited the Nigeria Naval Reference Hospital (NNRH) Calabar when compared to other study sites, although the prevalence difference between the study sites was not statistically significant (p= 0.4519). The higher prevalence of UTI in these patients could be attributed to the status of NNRH as reference hospital where advanced

Table 3: Association of clinical symptoms and potential risk factors with symptomatic significant bacteriuria/urinary tract infection among the study participants

Characteristics		**No of participants with significant bacteriuria**				**OR (95% CI)**	***p* value**
		NNRH (N = 94) n (%)	**UCTH (N = 62) n (%)**	**GHC (N = 71) n (%)**	**Total (N=227)**		
Clinical symptoms							
Urine urgency	Yes	3 (9.7)	0	2 (10.5)	5 (7.7)	1.85 (0.56-6.04)	.3315
	No	28 (90.3)	15 (100.0)	17 (89.5)	60 (92.3)		
Dysuria	Yes	7 (22.6)	5 (33.3)	7 (36.8)	19 (29.2)	2.07 (1.05-4.06)	**.**044*
	No	24 (77.4)	10 (66.7)	12 (63.2)	46 (70.8)		
Fever	Yes	4 (12.9)	1 (6.7)	6 (31.6)	11 (17.0)	0.56 (0.27-1.18)	.1672
	No	27 (87.1)	14 (93.3)	13 (68.4)	54 (83.1)		
Flank or supra-pubic pain	Yes	7 (22.6)	2 (13.3)	3 (15.8)	12 (18.5)	0.74 (0.36-1.52)	.4808
	No	24 (77.4)	13 (86.7)	16 (84.2)	53 (81.5)		
Frequency of urination	Yes	4 (12.9)	9 (60.0)	7 (36.8)	19 (29.2)	1.26 (0.13-1.19)	.5055
	No	27 (87.1)	6 (40.0)	12 (63.2)	46 (70.8)		
Risk factors							
Pregnancy status	Yes	5 (25.0)	3 (75.0)	5 (33.3)	13 (33.3)	9.94 (3.87-25.57)	<.0001*****
	No	15 (75.0)	1 (25.0)	10 (66.7)	26 (66.7)		
Use of drug without prescription	Yes	7 (22.6)	5 (33.3)	6 (31.6)	18 (28.6)	0.99 (0.52-1.89)	1.000
	No	24 (77.4)	10 (66.7)	13 (68.4)	47 (71.4)		
Previous history of UTI	Yes	17 (54.8)	11 (73.3)	8 (42.1)	36 (55.4)	2.86 (1.58-5.18)	.0008*
	No	14 (45.2)	4 (26.7)	11 (57.9)	29 (44.6)		
History of catheterization	Yes	1 (3.2)	3 (20.0)	1 (5.3)	5 (7.7)	4.42 (1.02-19.05)	.0450*
	No	30 (96.8)	12 (80.0)	18 (94.7)	60 (92.3)		
Family history of UTI	Yes	16 (51.6)	9 (60.0)	14 (73.7)	37 (57.0)	1.23 (0.69-2.19)	.5568
	No	15 (48.4)	6 (40.0)	5 (26.3)	28 (43.1)		
Diabetes	Yes	0	2 (13.3)	0	2 (3.1)	5.11 (0.46-57.37)	.1979
	No	31 (100.0)	13 (86.7)	19 (100.0)	63 (97.0)		
Use of contraceptive	Yes	2 (10.0)	2 (50.0)	6 (40.0)	10 (25.6)	3.47 (1.45-8.32)	.012*
	No	18 (90.0)	2 (50.0)	9 (60.0)	29 (74.4)		

NNRH = Nigeria Navy Reference Hospital Calabar; UCTH = University of Calabar Teaching Hospital; GHC = General Hospital Calabar; OR=Odds ratio; CI=Confidence interval; *Statistically significant at $P < .05$; N = Total number of participants with bacteriuria; n = no of participants with significant bacteriuria/urinary tract infection

Table 4: Prevalence of uropathogens isolated from patients by gender, study site, and age group

Identified bacteria/ participant characteristics	**No of bacteria pathogen isolated from significant urine culture**									
	Gender (%)		**Study location (%)**			**Age group (years) (%)**				**Total (%)**
	Males	**Females**	**NNRH**	**UCTH**	**GHC**	**5-18**	**19-29**	**30-45**	**>45**	
Gram negative bacteria										
Serratia marcescens	1 (3.8)	4 (10.3)	2 (6.5)	1 (6.7)	2 (10.5)	0	3 (12.0)	2 (8.3)	0	5 (7.7)
Escherichia coli	4 (15.4)	4 (10.3)	3 (9.7)	2 (13.3)	3 (15.7)	0	4 (16.0)	3 (12.5)	1 (8.3)	8 (12.3)
Cronobacter species	0	2 (5.1)	1 (3.2)	0	1 (5.3)	0	0	2 (8.3)	0	2 (3.1)
Klebsiella pneumoniae	7 (26.9)	8 (20.5)	8 (25.8)	5 (33.3)	2 (10.5)	1 (25.0)	5 (20.0)	7 (29.2)	2 (16.7)	15 (23.1)
Enterobacter cloacae	1 (3.8)	6 (15.4)	4 (12.9)	1 (6.7)	2 (10.5)	2 (50.0)	2 (8.0)	2 (8.3)	1 (8.3)	7 (10.8)
Citrobacter freundii	1 (3.8)	5 (12.8)	2 (6.5)	1 (6.7)	3 (15.7)	1 (25.0)	3 (12.0)	1 (4.2)	1 (8.3)	6 (9.2)
Pseudomonas luteola	1 (3.8)	0	1 (3.2)	0	0	0	1 (4.0)	0	0	1 (1.5)
Proteus mirabilis	3 (11.5)	2 (5.1)	3 (9.7)	0	2 (10.5)	0	3 (12.0)	0	2 (16.7)	5 (7.7)
Citrobacter koseri	1 (3.8)	0	0	0	1 (5.3)	0	1 (4.0)	0	0	1 (1.5)
Pseudomonas aeruginosa	1 (3.8)	1 (2.6)	1 (3.2)	1 (6.7)	0	0	0	1 (4.2)	1 (8.3)	2 (3.1)
Gram positive bacteria										
Enterococcus species	1 (3.8)	1 (2.6)	1 (3.2)	0	1 (5.3)	0	1 (4.0)	1 (4.2)	0	2 (3.1)
Staphylococcus species	5 (19.2)	6 (15.4)	5 (16.1)	4 (26.7)	2 (10.5)	0	2 (8.0)	5 (20.8)	4 (33.3)	11 (16.9)
Total	26 (40.0)	39 (60.0)	31 (47.8)	15 (23.1)	19 (29.2)	4 (6.2)	25 (38.5)	24 (36.9)	12 (18.5)	65 (100.0)

NNRH = Nigeria Navy Reference Hospital Calabar; UCTH = University of Calabar Teaching Hospital; GHC = General Hospital Calabar

level of healthcare services and diagnoses are conducted. This observation is in consonance with the study of Karikari et al., (9) in Ghana, who reported high incidence of UTI in a referral hospital.

The age group 19-29 years had the highest prevalence of UTI (30.5%, 25/82) among the study participants closely followed by age group >45 years (30.0%, 12/40). This age group also had the highest UTI prevalence in GHC (35.3%, 12/34) but the age group 5-18 years had the highest prevalence in NNRH (44.4%, 4/9) while age group >45 years had the highest prevalence in UCTH (29.4%, 5/17). Nevertheless, this prevalence difference in the entire study participants (and with respect to study sites) was not statistically significant (p=0.946). This finding is in consonance with Ndako et al., (19) in southwest Nigeria, Abdul et al., (21) in Maiduguri, northeast Nigeria, and Mokube et al., (8) in Cameroon. In contrast, Obirikorang et al., (22) reported highest prevalence of UTI in age group 30-34 years in Kumasi, Ghana, and Marami et al., (23) in age group 35-44 years in Ethiopia. This variation in prevalence of UTI with respect to age group might be due to the target population under study, previous untreated history, family history, underlying medical condition, sexual activity, and educational level, among other factors as previously reported (5,24).

In this study, the prevalence of UTI was slightly higher in females (28.9%, 39/135) than in males (28.3%, 26/92), although this was not statistically significant (p=0.918). This finding is consistence with previous studies supporting that women are more vulnerable to contracting UTI due to their short urethra and its proximity to the anal opening (25,26). Other factors which may contribute to high incidence of UTI in women are physiological changes in women which deplete the vaginal flora, unauthorized administration of contraceptives, pregnancy, and family history (4). However, in UCTH, the UTI prevalence of 37.9% (11/29) in the male participants was significantly higher than 12.1% (4/33) in the female participants (p=0.0384). This is contrary to what has been previously established, and the cause of this reversal is not apparent in this center.

The prevalence of UTI was higher among the married (33.6%, 37/110) compared to single participants (24.1%, 27/112). Although this difference was not statistically significant among the entire study participants (p=0.347), it was statistically significant for participants in GHC, where the prevalence was 30.8% (8/26) in married compared to 24.4% (11/45) in singles (p=0.0280). This is in agreement with the finding of Ezugwu et al., (27) but contradicts Wanja et al., (28) in Kenya, who reported highest prevalence of UTIs among widowed (57.1%). The highest prevalence of UTI among married participants in this study may be attributed to increase in parity or a higher number of pregnancies (27).

Participants with secondary educational qualification had the highest prevalence of UTI (33.8%, 22/65), followed by those with primary (28.0%, 7/25) and tertiary education (27.3%, 35/128). Although the difference in the prevalence was not statistically significant (p=0.508), in GHC, participants who attended tertiary education had the highest prevalence of UTI (31.1%, 14/45). This variation may be attributed to the proximity of University of Calabar to this site. Multiple sexual partners and unfaithfulness to one sex partner have been found as indicators of UTI among university students (29). Studies have shown that people with little or no formal education had higher prevalence of UTIs (30,31), which agrees with the present findings but contradicts those of Ndako et al., (19) and Mokube et al., (8). On the basis of occupation, the UTI prevalence was highest among artisan (71.4%, 5/7) followed by civil servants (44.4%, 4/9) and lowest among students (13.6%, 3/22), trader (13.3%, 2/15) and farmers (11.1%, 1/9). The observed difference was statistically significant (p=0.003), which agrees with findings of previous studies (32,33).

Of all the clinical symptoms, only dysuria was significantly associated with UTI (OR =2,065 95% CI=1.051-4.059, p=0.044). This contradicted the study of Seifu and Gebissa (34) who reported that fever, urgency, frequency and supra-pubic pain were significantly associated with UTI, but agrees with Al-Kashif (35) who reported statistical association of dysuria with UTI. In line with earlier studies (5,6,35,36), pregnancy, previous history of UTI, history of catheterization and contraceptive use were significantly associated with the occurrence of UTI in our current study. This may be attributed to factors such as contamination of catheter during insertion, and physiological changes of pregnancy and oral contraceptive pills on the urinary system in the females. Contrary to Odoki et al., (10) and Ahmed (37), the present study showed that family history of UTI and diabetes mellitus were not significantly associated with UTI (p> 0.05).

The severity of UTI is greatly influenced by the types of organisms involved. In this study, Gram-negative uropathogens constituted 80% while Gram-positive constituted 20%. This supports the assertion that Gram-negative bacteria constitute 80-90% of uropathogens (38). The uropathogens recovered in this study had previously been known to cause UTI (6,7,17,26). The highest prevalence of *K. pneumoniae* in our study is an indication that

this organism is achieving more prominence as causative agents of UTI. This finding is inconsistent with that of Seifu and Gebissa (34) in Ethiopia who reported *E. coli* as the most common uropathogens from UTI patients. In other reports, Many et al., (39) in Democratic Republic of Congo (DRC) reported *P. mirabilis* (41.2%), Labi et al., (24) in Ghana reported *Enterococcus* sp. (26.7%) and Musonda et al., (40) in Zambia reported *S. aureus* (32%) as the most predominant organism. The variation in the type of bacteria uropathogens in this study and others reported might be attributed to physiological state of patients, techniques of sample collection, sample size used, environmental or personal hygi ene levels.

Our study reported the presence of *Cronobacter* sp. in the urine samples. *Cronobacter* sp. has been reported as emerging pathogens from infant food (41). UTI caused by *Cronobacter* sp. in the study area is rare. However, this study agrees with Hayashi et al., (42) who reported the occurrence of *Cronobacter sakazakii* in a 69-year-old man presenting with UTI in Shimane University Hospital, Shimane, Japan. The possible route of infection with *Cronobacter* sp could be via oral ingestion from external sources and retrograde transmission through the urinary tract (42).

Conclusion:

In our study, the overall prevalence of symptomatic significant bacteriuria/UTI among patients attending hospitals in Calabar, Nigeria was 28.6%. Of all considered risk factors, previous history of UTI, pregnancy, contraceptives and history of urinary catheterization were significantly associated with prevalence of UTI. Similarly, there was significant association of dysuria symptom with UTI and artisans had significantly higher prevalence of UTI compared to other occupational groups.

Klebsiella pneumoniae was the most predominant uropathogens, followed by coagulase-negative staphylococci and others such as *E. coli*, *E. cloacae*, *C. freundii*, *P. mirabilis*, *S. marcescens*, *P. aeruginosa*, *Cronobacter* sp, *Enterococcus* sp, *C. koseri*, and *P. luteola*. Routine screening for UTI is recommended for pregnant women, patients with dysuria, previous episodes of UTI, and catheterized patients. Appropriate antimicrobial drugs should be promptly administered for positive cases.

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Contributions of authors:

EEB conceptualized and designed the study, collected, analyzed, interpreted the data, drafted and critically reviewed the manuscript; AAAA assisted in fund acquisition and critically reviewed the manuscript; EEI, MM and SSA critically reviewed the manuscript. All authors read and approved the manuscript.

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Authors declare no conflict of interest.

References:

1. Vasudevan, R. Urinary tract infection: An overview of the infection and the associated risk factors. J Microbiol Exp. 2014; 1(2): 42–54. doi: 10.15406/jmen.2014.01.00008.
2. Flores-Mireles, A. L., Walker, J. N., Caparon, M., and Hultgren, S. J. Urinary tract infections: Epidemiology, mechanisms of infection and treatment options. Nat Rev Microbiol. 2015; 13: 1-16.doi:10.1038/nrmicro3432.
3. Derbie, A., Hailu, D., Mekonnen, D., Abera, B., and Yitayew. G. Antibiogram profile of uropathogens isolated at Bahir Dar Regional health research laboratory centre, Northwest Ethiopia. Pan Afr Med J. 2017; 26: 134. doi:10.11604/pamj.2017.26.134.7827.
4. Mwang'onde, B. J., and Mchami, J. I. The aetiology and prevalence of urinary tract infections in Sub-Saharan Africa: a Systematic Review. J Health Biol Sci. 2022; 10 (1): 1-7.
5. Koffi, K. A., Aka, E. K., Apollinaire, H., Mlan-Britoh, A., and Konan, J. M. P. Epidemiological, bacteriological profile and bacterial resistance of urinary tract infections at pregnant woman in prenatal consultation in African setting. Int J Reprod Contracept Obstet Gynecol. 2020; 9: 461-467.
6. Donkor, E. S., Horlortu, P. Z., Dayie, N. T. K. D., Obeng-Nkrumah, N., and Labi, A-K. Community acquired urinary tract infections among adults in Accra, Ghana. Infect Drug Resist. 2019; 12: 2059–2067.
7. Iheanacho, J. N., Antai, S. P., and Tiku, D. R. Prevalence and microbial dynamics of urinary tract infection in a tertiary hospital in Calabar, Cross River State. World J Pharm Res. 2018; 7 (17): 291-307.
8. Mokube, M. N., Atashili, J., Halle-Ekane, G. E., Ikomey, G. M., and Ndumbe, P. M. Bacteriuria amongst pregnant women in the Buea Health District, Cameroon: Prevalence, predictors, antibiotic susceptibility patterns and diagnosis. PLoS One. 2013; 8 (8): e71086. doi:10.1371/journal.pone.0071086.

9. Karikari, A. B., Saba, C. K. S., and Yamik, D. Y. Reported cases of urinary tract infections and the susceptibility of uropathogens from hospitals in northern Ghana. Microbiol Insights. 2022; 15: 1-9. doi: 10.1177/17786361221106109.
10. Odoki, M., Aliero, A. A., Tibyangye, J., et al. Prevalence of bacterial urinary tract infections and associated factors among patients attending hospitals in Bushenyi District, Uganda. Int J Microbiol. 2019: 1-8. https://doi.org/10.1155/2019/4246780.
11. Obia, A. E., Itam, E. B., and Archibong, A. E. Urban development in the third world and threat to wetlands: The case study of Calabar, Nigeria. Glob J Eng Res. 2015; 14: 33-45. doi:http://dx.doi.org/10.4314/gjer.v14i1.5.
12. National Population Commission [NPC]. Population distribution by Sex, State, LGA & Senatorial district. 2010. https://www.google.com/url?sa=t&source=web&rct=j&url=https://catalog.ihsn.org/index.php/catalog/3340/download/48521&ved=2ahUKEwjV3PPG_pvxAhWBAGMBHeOhCPkQFjAAegQIAxAC&usg=AOvVaw0BRyy4fISrubdP5ouXNpD&cshid=1623840889468. (Accessed 05 March 2022).
13. Akmal-Hasan, S. K., Kumar, T. N., Kishan, N. R., and Neetha, K. Laboratory diagnosis of urinary tract infections using diagnostics tests in adult patients. Int J Res Med Sci. 2014; 2: 415-421. doi:10.5455/2320-6012.ijrms20140508.
14. Chessbrough M. District Laboratory Practice in Tropical Countries. 2nd ed. London: Cambridge University Press. 2006.
15. Mohamed, N. R., Omar, H. H. H., and Abd-Allah, I. M. Prevalence and risk factors of urinary tract infection among pregnant women in Ismailia city, Egypt. IOSR JNHS. 2017: 6; 62-72.
16. Dibua, U. M. E., Onyemerela, I. S., and Nweze, E. I. Frequency, urinalysis and susceptibility profile of pathogens causing urinary tract infections in Enugu state, Southeast Nigeria. Rev Inst Med Trop. 2014: 56 (1); 55-59. doi:10.1590/S0036-46652014000100008.
17. Jombo, G. T. A., Emanghe, U. E., Amefule, E. N., and Damen, J. G. Urinary tract infections at a Nigerian university hospital: Causes, patterns and antimicrobial susceptibility profile. J Microbiol Antimicrob. 2011; 3 (6): 153-159.
18. Irenge, L. M., Kabego, L., Vandenberg, O., Chirimwami, R. B., and Gala, J-L. Antimicrobial resistance in urinary isolates from inpatients and outpatients at a tertiary care hospital in South-Kivu Province (Democratic Republic of Congo). BMC Res Notes. 2014: *7*; 374. doi:10.1186/1756-0500-7-374.
19. Ndako, J. A., Owolabi, A. O., Oranusi, S. U., et al. Incidence of urinary tract infection in a rural community of south west, Nigeria. Saudi J Biomed Res. 2019: 4 (9); 306-311. doi:10.36348/SJBR.2019.v04i09.002.
20. Lawson, S. D., Ibiene, A. A., Omunakwe, H. E., Uzah, G. A., and Nnodim, L. C. The prevalence and trend of urinary tract infection among patients attending hospitals in Rivers State. J Med Microbiol Diagn. 2021: 10; 1-11.
21. Abdu, A., Kachallah, M., and Bolus, D. Y. Antibiotic susceptibility patterns of uropathogenic *Escherichia coli* among patients with urinary tract infections in a tertiary care hospital in Maiduguri, North Eastern, Nigeria. J Biosci Biotechnol Discov 2018: 3; 14-24.
22. Obirikorang, C., Quaye, L., Bio, F. Y., Amidu, N., Acheampong, I., and Addo, K. Asymptomatic bacteriuria among pregnant women attending antenatal clinic at the university hospital, Kumasi, Ghana. J Med Biomed Sci. 2012: 1 (1); 38-44.
23. Marami, D., Balakrishnan, S., and Seyoum, B. Prevalence, antimicrobial susceptibility pattern of bacterial isolates, and associated factors of urinary tract infections among HIV-positive patients at Hiwot Fana specialized university hospital, eastern Ethiopia. Can J Infect Dis Med Microbiol. 2019:1-8. https://doi.org/10.1155/2019/6780354.
24. Labi, A-K., Yawson, A. E., Ganyaglo, G. Y., and Newman, M. J. Prevalence and associated risk factors of asymptomatic bacteriuria in ante-natal clients in a large teaching hospital in Ghana. Ghana Med J. 2015; 49 (3): 154-158. http://dx.doi.org/10.4314/gmj.v49i3.5.
25. Mistry, M., Bhattacharya, A., and Mistry, A. Aerobic bacteriological profile and antibiotic susceptibility pattern of urinary tract infections in patients of intensive care unit at a tertiary care hospital, Rajkot. Int J Recent Sci Res. 2022: 13 (01); 161-165. http://dx.doi.org/10.24327/ijrsr.2022.1301.0032.
26. Nzalie, R. N., Gonsu, H. K., and Koulla-Shiro, S. Bacterial etiology and antibiotic resistance profile of community-acquired urinary tract infections in a Cameroonian city. Int J Microbiol. 2016: 1-6. http://dx.doi.org/10.1155/2016/3240268.
27. Ezugwu, I. A., Afunwa, R. A., Onyia, F. C., et al. Prevalence of urinary tract infections and associated risk factors among pregnant women in Enugu metropolis, Nigeria. Int J Biosci Med. 2021: 9; 156-171. https://doi.org/10.4236/jbm.2021.910014.
28. Wanja, F., Ngugi, C., Omwenga, E., Maina, J., and Kiiru, J. Urinary tract infection among adults seeking medicare at Kiambu level 5 hospital, Kenya: Prevalence, diversity, antimicrobial susceptibility profiles and possible risk factors. Adv Appl Microbiol. 2021: 11; 360-383. https://doi.org/10.4236/aim.2021.118028.
29. Gebremariam, G., Legese, H., Woldu, Y., Araya, T., Hagos, K., and Gebreyesus Wasihun, A. Bacteriological profile, risk factors and antimicrobial susceptibility patterns of symptomatic urinary tract infection among students of Mekelle university, northern Ethiopia. BMC Infect Dis. 2019: 19; 950. https://doi.org/10.1186/s12879-019-4610-2.
30. Worku, G. Y., Alamneh, Y. B., and Abegaz, W. E. Prevalence of bacterial urinary tract infection and antimicrobial susceptibility patterns among diabetes mellitus patients attending Zewditu memorial hospital, Addis Ababa, Ethiopia. Infect Drug Resist. 2021: 14; 1441-1454.
31. Tessema, N. N., Ali, M. M., and Zenebe, M. H. Bacterial associated urinary tract infection, risk factors, and drug susceptibility profile among adult people living with HIV at Haswassa university comprehensive specialized hospital, Hawassa, southern Ethiopia. Sci Rep. 2020: 10; 10790. https://doi.org/10.1038/s41598-020-67840-7.
32. Ani, C. O., Odeta, N. P., and Obasi, S. O. Burden of urinary tract infection (UTI) among female students: South eastern Nigeria side of the story. Int J Trop Dis Health. 2016; 12 (2): 1-7. doi:10.9734/IJTDH/2016/22390.
33. Al-Gasha'a, F. A. S., Al-Baker, S. M., Obiad, J. M., and Alrobiai, F. A. Prevalence of urinary tract infections and associated risk factors among patients attending medical city hospital in Baghdad city, Iraq. Am J Infect Dis. 2020: 16 (2);77-84.doi:10.3844/ajidsp.2020.77.84.
34. Seifu, W. D., and Gebissa, A. D. Prevalence and antibiotic susceptibility of uropathogens from cases of urinary tract infections (UTI) in Shashemene referral hospital, Ethiopia. BMC Infect Dis. 2018; 18: 30. doi:10.1186/s12879-017-2911-x.
35. Al-Kashif, M. M. L. Urinary tract infection among pregnant women and its associated risk factors: A cross-sectional study. Biomed Pharmacol J. 2019; 12 (4): 2003 - 2010. http://dx.doi.org/10.13005/bpj/1832.
36. Belete, M. A. Bacterial profile and ESBL screening of urinary tract infection among asymptomatic

and symptomatic pregnant women attending antenatal care of northeastern Ethiopia region. Infect Drug Resist. 2020; 13: 2579–2592.

37. Ahmed, O. B. Bacterial profile and antimicrobial susceptibility pattern of urinary tract infection in Khartoum, Sudan. Int J Curr Res. 2015; 7 (11): 22344–22347.
38. Vinod, P. V., and Selvaraj, P. R. Study on the prevalence of urinary tract infection among the Paliyar Indian tribe. Int J Curr Res. 2012: 4 (01); 044-048. http://www.journalcra.com.
39. Many, M. R., Yves, M. K., Celestin, N. N., and Richard, B. M. Investigation of antimicrobial resistance in urinary tract infection in children at the east party of democratic Republic of Congo. J Bacteriol Mycol. 2019; 7 (3): 50–53. doi: 10.15406/jbmoa.2019.07.00242.
40. Musonda, T., Zulu, M., Samutela, M., Kalonda, A., Mantina, H., and Okuku, P. Leucocytosis and asymptomatic urinary tract infections in sickle cell patients at a tertiary hospital in Zambia. Anemia. 2020: 1-5. https://doi.org/10.1155/2020/3792728.
41. Pakbin, B., Brück, W. M., Allahyari, S., Rossen, J. W. A., and Mahmoudi, R. Antibiotic resistance and molecular characterization of *Cronobacter sakazakii* strains isolated from powdered infant formula milk. Foods.2022; 11: 1093. https://doi.org/10.3390/foods11081093.
42. Hayashi, S., Takinami, Y., and Watari, T. Urinary tract infection caused by *Cronobacter sakazakii*. Cureus. 2021; 13 (6): e15780. doi: 10.7759/cureus.15780.