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## Original Article

## Open Access

# Prevalence of symptomatic urinary tract infection and bacterial spectrum of diabetic and non-diabetic patients at the two teaching hospitals in Enugu, Nigeria

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## Abstract:

**Background:** Diabetes mellitus is a group of metabolic disorder characterized by relative or absolute lack of insulin. When this condition is not properly managed, it can lead to complications that make diabetic patients vulnerable to urinary tract infections (UTI). The objectives of this study are to determine the prevalence of microbiologically confirmed UTI and the spectrum of uropathogens in diabetic and non-diabetic patients with clinical features of UTI attending the two tertiary hospitals in Enugu State, Nigeria.

**Methodology:** Clean catch specimen of single mid-stream urine sample was collected from each of 60 (22 males, 38 females) diabetic and 60 (22 males, 38 females) non-diabetic patients enrolled using stratified random sampling method. The samples were cultured on standard microbiological culture media (MacConkey and Blood agar plates) and incubated aerobically at 37°C for 24 hours. Plates with significant bacteria growth ( $>10^5$  CFU/ml) were processed further for bacterial identification using conventional biochemical test scheme. Antibiotic susceptibility test (AST) of each isolate to 17 selected antibiotics was performed by the modified disc diffusion method.

**Results:** Of the total 120 patients enrolled, 101 had bacterial pathogens isolated from their voided urine samples; 51 of 60 (85.0%) diabetics and 50 of 60 (83.3%) non-diabetics ( $p=0.802$ ). Bacteria were isolated in 59.1% (13/22) of diabetic and 54.5% (12/22) of non-diabetic male patients compared to 100% (38/38) isolation rate in diabetic and non-diabetic female patients. The most frequently isolated bacteria in the diabetic patients were *Proteus* spp (18.6%), *Klebsiella* spp (16.9%) and *Escherichia coli* (15.5%) while the most frequently isolated bacteria among the non-diabetic patients were *E. coli* (30.0%), *Proteus* spp (26.3%) and *Enterobacter* spp (14.0%). Apart from *Klebsiella* spp which was more frequently isolated from the diabetic (16.9%) than non-diabetic patients (6%) ( $p=0.039$ ), the frequency other bacterial pathogen isolation such as *Proteus* spp, *E. coli*, *Enterobacter* spp, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Enterococcus* spp was not significantly different between the two population groups ( $p>0.05$ ). The Gram-positive and Gram-negative bacteria were highly sensitive to imipenem in both diabetic and non-diabetic patients, but the isolates from both study groups exhibited low susceptibility to amoxicillin, nitrofurantoin, cefixime and cefuroxime.

**Conclusion:** Although the overall frequency of bacterial pathogen isolation in the diabetic and non-diabetic patients was not significantly different, females had a higher pathogen isolation rate than the males, and diabetic females had a higher frequency of polymicrobial infections compared to non-diabetic females and the male population. The high antimicrobial resistance of the isolated bacteria pathogens underscores the need for clinical microbiology laboratory testings to optimize the management of UTI in diabetic patients.

**Keywords:** UTI; Diabetes mellitus; Antibigram; Significant bacteriuria; Pathogen; Enugu

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# Prévalence des infections urinaires symptomatiques et spectre bactérien des patients diabétiques et non diabétiques dans les deux hôpitaux universitaires d'Enugu, au Nigeria

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## Abstrait:

**Contexte:** Le diabète sucré est un groupe de troubles métaboliques caractérisés par un manque relatif ou absolu d'insuline. Lorsque cette condition n'est pas correctement gérée, elle peut entraîner des complications qui rendent les patients diabétiques vulnérables aux infections des voies urinaires (UTI). Les objectifs de cette étude sont de déterminer la prévalence des infections urinaires confirmées microbiologiquement et le spectre des uropathogènes chez les patients diabétiques et non diabétiques présentant des caractéristiques cliniques des infections urinaires fréquentant les deux hôpitaux tertiaires de l'État d'Enugu, au Nigeria.

**Méthodologie:** Un échantillon de capture propre d'un seul échantillon d'urine à mi-jet a été prélevé sur chacun des 60 (22 hommes, 38 femmes) patients diabétiques et 60 (22 hommes, 38 femmes) patients non diabétiques inscrits à l'aide d'une méthode d'échantillonnage aléatoire stratifié. Les échantillons ont été cultivés sur des milieux de culture microbiologiques standard (plaques de gélose MacConkey et Blood) et incubés en aérobie à 37°C pendant 24 heures. Les plaques avec une croissance bactérienne significative ( $>10^5$  CFU/ml) ont été traitées davantage pour l'identification bactérienne en utilisant un schéma de test biochimique conventionnel. Le test de sensibilité aux antibiotiques (AST) de chaque isolat à 17 antibiotiques sélectionnés a été réalisé par la méthode de diffusion sur disque modifiée.

**Résultats:** Sur un total de 120 patients recrutés, 101 avaient des agents pathogènes bactériens isolés de leurs échantillons d'urine évacués; 51 des 60 (85,0%) diabétiques et 50 des 60 (83,3%) des non-diabétiques ( $p=0,802$ ). Les bactéries ont été isolées chez 59,1% (13/22) des patients diabétiques et 54,5% (12/22) des hommes non diabétiques contre un taux d'isolement de 100% (38/38) chez les femmes diabétiques et non diabétiques. Les bactéries les plus fréquemment isolées chez les patients diabétiques étaient *Proteus* spp (18,6%), *Klebsiella* spp (16,9%) et *Escherichia coli* (15,5%) tandis que les bactéries les plus fréquemment isolées chez les patients non diabétiques étaient *E. coli* (30,0%), *Proteus* spp (26,3%) et *Enterobacter* spp (14,0%). Hormis *Klebsiella* spp qui était plus fréquemment isolé chez les diabétiques (16,9%) que les patients non diabétiques (6%) ( $p=0,039$ ), la fréquence d'isolement d'autres agents pathogènes bactériens tels que *Proteus* spp, *E. coli*, *Enterobacter* spp, *Pseudomonas aeruginosa*, *Staphylococcus aureus* et *Enterococcus* spp n'étaient pas significativement différents entre les deux groupes de population ( $p>0,05$ ). Les bactéries Gram-positives et Gram-négatives étaient très sensibles à l'imipénème chez les patients diabétiques et non diabétiques, mais les isolats des deux groupes d'étude présentaient une faible sensibilité à l'amoxicilline, à la nitrofurantoïne, au céfixime et à la céfuroxime.

**Conclusion:** Bien que la fréquence globale d'isolement des agents pathogènes bactériens chez les patients diabétiques et non diabétiques n'était pas significativement différente, les femmes avaient un taux d'isolement des agents pathogènes plus élevé que les hommes, et les femmes diabétiques avaient une fréquence plus élevée d'infections polymicrobiennes par rapport aux femmes non diabétiques. et la population masculine. La haute résistance antimicrobienne des bactéries pathogènes isolées souligne la nécessité de tests de laboratoire de microbiologie clinique pour optimiser la gestion des infections urinaires chez les patients diabétiques.

**Mots-clés:** UTI; diabète sucré; Antibiogramme; Bactériurie importante; Agent pathogène; Enugu

## Introduction:

Simple urinary tract infection (UTI) is inflammation of the urinary system usually manifesting with frequency, urgency, dysuria, or suprapubic pain in affected patients while complicated UTI occurs in the setting of functional or structural abnormalities of the urinary tracts. Quantitative criterium for establishing a UTI is significant bacteriuria of at least 100,000

colony forming unit (CFU) per ml of urine in a voided midstream clean catch specimen (1).

Evidence has shown that the incidence of UTI in diabetic patients is four times higher than in non-diabetic patients (2). It has also been reported that the occurrence of UTI in diabetic patients is higher in people with low socioeconomic status and the resistant patterns of microorganisms isolated in diabetic patients differs from those from non-diabetic patients

(3). Regrettably, treatment of UTI in patients with diabetes is usually associated with worse outcome compared to those without diabetes, seemingly because diabetics seem to have greater difficulty in handling infection once they occur (4,5). Indeed, several aspects of immune system are altered in diabetic patients; polymorphonuclear leukocyte function is compromised particularly when acidosis is present, and adherence, chemotaxis, phagocytosis and bactericidal activity of the leukocytes may also be depressed (6).

UTI is a serious health challenge affecting millions of people each year. In the United States of America, it is estimated from surveys of office practices, hospital-based clinics and emergency departments that there are over eight million cases of UTI annually (7). Many studies have reported incidence of UTI among patients with diabetes mellitus, for example, an observational study of all patients within the United Kingdom general practice research database reported incidence rate of UTI of 46.9 per 1000 persons among diabetic patients versus 29.9 per persons for patients without diabetes (8). An American database study during 2014 (9) found that a UTI diagnosis was more common in subjects with diabetes compared to those without diabetes (9.4% vs 5.7%). Another study in USA with over 70000 patients with diabetes type 2 reported 8.2% with diagnosis of UTI in one year (10). A Canadian study reported that diabetic females were 6-15 times more frequently hospitalized for acute pyelonephritis than non-diabetic females, and diabetic males were hospitalized 3.4-17 times more than non-diabetic males (11). In a study conducted in Europe, bacteriuria was more prevalent among women with diabetes (26%) than in women without diabetes (6%) (12).

In Nigeria, the prevalence of UTI tend to vary depending on the study population and risk factors. For instance, a prevalence of 61.0% was reported among pregnant women (13) while a prevalence of 46% was reported in diabetic patients in Abakaliki (14). Among HIV-infected children and adolescents, a prevalence rate of 32.5% was reported (15) while 43.6% rate was reported in the general population without reported risks for UTI (16). In the present study, we determined the prevalence of symptomatic UTI and spectrum of uropathogens among 60 diabetic and 60 non-diabetic patients attending the two tertiary hospitals in Enugu State, Nigeria.

## Materials and method:

### Study area

The study was conducted in the two teaching hospitals in Enugu; University of Nigeria Teaching Hospital (UNTH) and Enugu State University Teaching Hospital (ESUTH), Parklane, Enugu State, Nigeria. The study participants were from out-patient clinics and in-patient general wards of these two hospitals.

### Study design and study population

This was a cross-sectional comparative study of the study population that included diabetic and non-diabetic patients with clinical symptoms and signs of UTI attending the out-patient clinics or hospitalized in the general wards of the two hospitals.

### Ethical approval

Ethical approval was obtained from the Health Research Ethics committee of the University of Nigeria Teaching Hospital Enugu (UNTH/CSA/329/OL.5).

### Subject participants and sampling method

A total of 120 participants with symptoms and signs suggestive of UTI were enrolled into the study, including 60 diabetic (22 males and 38 females), and 60 non-diabetic patients (22 males and 38 females) using stratified random sampling technique. Pooled subjects were divided into groups with similar attributes. Then, simple random sample was taken from each group to ensure that different segments in the population were equally represented. Inclusion criteria were patients of all gender and age groups with symptoms and signs suggestive of UTI, history of diabetes (for the diabetics), and no history of diabetes (for the non-diabetics). Exclusion criteria included pregnancy, history of other underlying illness like HIV/AIDS, and antibiotic usage within 14 days preceding the enrolment

Diabetic patients were enrolled into the study during their regular visits at the endocrinology units of the hospitals through the assistance of their physicians and nurses, while non-diabetics were apparently healthy individuals who were on visit for diabetic status check and confirmed by glucometer measurement of fasting blood glucose (FBS)  $\leq$  126 mg/dl.

### Collection of urine samples

Urine samples (about 10ml) were collected from the study participant who were first

educated on how to collect a 'clean-catch' midstream urine specimen and the importance of avoiding contamination. They were advised on proper hand washing prior to collection and separation of labia (in females). Urine samples were collected into sterile containers with boric acid preservative and transported to the laboratory within 2 hours.

#### Urine microscopy, culture and bacteria isolation

Each urine sample was cultured on MacConkey agar and Blood agar plates which had been prepared according to manufacturer's instructions. The urine was properly mixed by rotating the container. An inoculating wire loop of 3mm diameter was used to inoculate a loopful (~10 $\mu$ l) of the urine sample onto freshly prepared agar and the plates were incubated aerobically at 37°C for 24 hours (17). The dip stick test on each urine sample was performed using Combi-10 urine test strips to determine urinary nitrite level and protein/glucose as adjunctive in detecting UTI and screening for diabetic nephropathy, respectively. Wet preparation of centrifuged urine was also examined using the 40x objective lens to detect blood, white blood cells (WBC), epithelial cell, casts, and other cells in the voided urine.

#### Identification of bacterial isolates

Culture plates were examined after 24 hours incubation for colony appearance, size, colour, pigmentation, haemolysis, consistency (mucoid, rough, stringy etc), odor, and evidence of lactose fermentation on MacConkey agar. Only plates with significant bacteriuria (> 10<sup>5</sup> CFU/ml or > 1000 colonies) were processed for bacterial identification. Isolates were identified by their Gram stain reactions and by conventional biochemical tests which included catalase and coagulase tests for Gram-positive bacteria, and oxidases, indole, methyl red, Voges Proskauer, urease, litmus milk decolorization, Kligler iron agar (KIA) and citrate utilization tests for Gram-negative bacteria as previously described (17).

#### Antibiotic susceptibility testing

Antibiotic susceptibility testing for each isolate was carried out by the Kirby Bauer disc diffusion technique using the Clinical and Laboratory Standards Institute (CLSI) guideline (18). A total of 17 antibiotic discs (HiMedia, Mumbai, India) were employed, which included; ciprofloxacin (10 $\mu$ g), cefuroxime (10 $\mu$ g), amoxicillin (30 $\mu$ g), chloramphenicol (10 $\mu$ g), ofloxacin (10 $\mu$ g), gentamicin (10 $\mu$ g), erythromycin

(10 $\mu$ g), ceftriaxone (30 $\mu$ g), streptomycin (30 $\mu$ g), nitrofurantoin (100 $\mu$ g), levofloxacin (5 $\mu$ g), norfloxacin (10 $\mu$ g), cefixime (5 $\mu$ g), ampicillin/cloxacillin (30 $\mu$ g), imipenem (10 $\mu$ g), clindamycin (10 $\mu$ g), and pefloxacin (10 $\mu$ g). A suspension of pure colonies of isolated bacteria were inoculated into 0.9% saline solution and standardized by comparing with 0.5 MacFarland turbidity standard. The surface of sterile Mueller Hinton (MH) agar plate was inoculated using sterile cotton swab soaked in bacterial suspension. Antibiotic discs were placed on inoculated agar plates using sterile forcep, and the plates incubated aerobically at 37°C for 24 hours. The diameter of zones of inhibition to each antibiotic disc was measured using a calibrated meter rule and results interpreted as sensitive or resistant according to CLSI guideline (18).

#### Data analysis

Data were analysed using the Statistical Package for the Social Sciences (SPSS) version 23.0 window-based program. Two tail Chi-square test was used to determine association between two categorical variables and  $p < 0.05$  was regarded as significant at 95% confidence interval.

#### Results:

A total of 120 patients; 60 diabetics (22 males, 38 females) and 60 non-diabetics (22 males, 38 females) with clinical symptoms and signs of UTI were studied. Of the 120 patients, 101 had bacterial pathogens isolated from their voided urine samples; 51 of 60 (85.0%) diabetics and 50 of 60 (83.3%) non-diabetics. The frequency of bacterial pathogen isolation (microbiologically documented UTI) was not significantly different between the two groups ( $p=0.802$ ) (Table 1).

The most frequently isolated pathogens in the diabetic patients were *Proteus* spp (18.6%), *Klebsiella* spp (16.9%) and *Escherichia coli* (15.5%) while the most frequently isolated pathogens among the non-diabetic patients were *E. coli* (30.0%), *Proteus* spp (26.3%) and *Enterobacter* spp (14.0%). Apart from *Klebsiella* spp which was significantly more frequently isolated from the diabetic (16.9%) than non-diabetic patients (6%) ( $p=0.039$ ), the frequency of isolation of other bacterial pathogens such as *Proteus* spp, *E. coli*, *Enterobacter* spp, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Enterococcus* spp

was not significantly different between the two population groups ( $p>0.05$ ). However, *Salmonella* spp, *Citrobacter* spp and *Providencia* spp were exclusively isolated from diabetic patients while *Corynebacterium* spp was the only pathogen exclusively isolated from one non-diabetic patient.

As shown in Table 2, bacterial pathogens were isolated in only 59.1% (13/22) of diabetic and 54.5% (12/22) of non-diabetic male patients compared to 100% (38/38) isolation rate in the diabetic and non-diabetic female patients. A total of 46 bacterial pathogens were isolated from the 38 diabetic females indicating polymicrobial infections in

some of them while there was only one pathogen (monomicrobial infection) isolated from the non-diabetic female patients and from both the male diabetic and non-diabetic patients.

Tables 3a and 3b showed the percentage sensitivity of the bacterial isolates from diabetic and non-diabetic patients to selected antibiotics. The Gram-positive and Gram-negative bacteria were highly sensitive to imipenem in both diabetic and non-diabetic patients, but the isolates from both study groups exhibited low susceptibility to amoxicillin, nitrofurantoin, cefixime and cefuroxime.

Table 1: Frequency distribution of bacterial isolates from diabetic and non-diabetic patients with urinary tract infections in the two teaching hospitals in Enugu, Nigeria

<b>Bacterial Isolates</b>	<b>Diabetics n (%)</b>	<b>Non-diabetics n (%)</b>	<b>Total n (%)</b>	<b>p value</b>
<i>Proteus</i> spp	11 (18.6)	13 (26.3)	24 (22.0)	0.332
<i>Klebsiella</i> spp	10 (16.9)	3 (6.0)	13 (11.9)	0.039*
<i>Escherichia coli</i>	9 (15.3)	15 (30.0)	24 (22.0)	0.171
<i>Pseudomonas aeruginosa</i>	7 (11.9)	3 (6.0)	10 (9.2)	0.186
<i>Salmonella</i> spp	6 (10.2)	0	6 (5.5)	NA
<i>Enterobacter</i> spp	2 (3.4)	7 (14.0)	9 (8.3)	0.083
<i>Citrobacter</i> spp	1 (1.7)	0	1 (0.9)	NA
<i>Providencia</i> spp	1 (1.7)	0	1 (0.9)	NA
<i>Staphylococcus aureus</i>	6 (10.2)	5 (10.0)	11 (10.1)	0.751
<i>Enterococcus</i> spp	6 (10.2)	3 (6.0)	9 (8.3)	0.298
<i>Corynebacterium</i> spp	0	1 (2.0)	1 (0.9)	NA
<b>Total no of isolates</b>	<b>59</b>	<b>50</b>	<b>109</b>	
No of patients with isolates	51 (85.0)	50 (83.3)	101 (84.2)	0.802
No of patients without isolates	9 (15.0)	10 (16.7)	19 (15.8)	
<b>Total no of patients</b>	<b>60 (100)</b>	<b>60 (100)</b>	<b>120</b>	

n = number of patients; \* = statistically significant; NA = not applicable

Table 2: Gender distribution of bacterial isolates from diabetic and non-diabetic patients with urinary tract infection in the two teaching hospitals in Enugu, Nigeria

Bacterial isolates	Diabetics (n %)				Non-diabetics (n %)			
	Males	Females	Total	p value	Males	Females	Total	p value
<i>Proteus</i> spp	2 (15.4)	9 (19.2)	11 (18.6)	0.756	4 (33.3)	9 (18.8)	13 (26.3)	0.272
<i>Klebsiella</i> spp	1 (7.7)	9 (19.2)	10 (16.9)	0.326	0	3 (6.3)	3 (6.0)	NA
<i>Escherichia coli</i>	1 (7.7)	8 (17.0)	9 (15.3)	0.376	3 (25)	12 (25.0)	15 (30.0)	0.100
<i>Pseudomonas aeruginosa</i>	2 (15.4)	5 (10.6)	7 (11.9)	0.637	1 (8.3)	2 (4.2)	3 (6.0)	0.553
<i>Salmonella</i> spp	1 (7.7)	5 (10.6)	6 (10.2)	0.754	0	0	0	NA
<i>Enterobacter</i> spp	1 (7.7)	1 (2.1)	2 (3.4)	0.322	1 (8.3)	6 (12.5)	7 (14.0)	0.687
<i>Citrobacter</i> spp	0	1 (2.1)	1 (1.7)	NA	0	0	0	NA
<i>Providencia</i> spp	0	1 (2.1)	1 (1.7)	NA	0	0	0	NA
<i>Staphylococcus aureus</i>	3 (23.1)	3 (6.4)	6 (10.2)	0.075	2 (16.7)	3 (6.3)	5 (10.0)	0.242
<i>Enterococcus</i> spp	2 (15.4)	4 (8.5)	6 (10.2)	0.464	1 (8.3)	2 (4.2)	3 (6.0)	0.553
<i>Corynebacterium</i> spp	0	0	0	NA	0	1 (2.1)	1 (2.0)	NA
<b>Total no of isolates</b>	<b>13</b>	<b>46</b>	<b>59</b>		<b>12</b>	<b>38</b>	<b>50</b>	
No of patients with isolates	13 (59.1)	38 (100)	51 (85)		12 (54.5)	38 (100)	50 (83.3)	
No of patients negative for isolates	9 (40.9)	0	9		10 (45.5)	0	10	
<b>Total no of patients</b>	<b>22</b>	<b>38</b>	<b>60</b>		<b>22</b>	<b>38</b>	<b>60</b>	

n = number of patients; NA = not applicable

## Discussion:

The overall prevalence rate of microbiologically confirmed bacterial UTI in this study was not significantly different ( $p=0.802$ ) among diabetic (85%, 51/60) and non-diabetic patients (83.3%, 50/60). This disagrees with the study of Saleem and Daniel (2) in Bangalore, India which reported that diabetic patients (56.4%) were significantly at increased risk of UTI than non-diabetics (43.6%). However, diabetic patients in our study who had microbiologically confirmed UTI had more bacterial pathogens isolated from their urine (51 patients had 59 pathogens) compared to the non-diabetic patients (50 patients had 50 pathogens), implying that some of the diabetic patients had polymicrobial infections, a situation that frequently occurs in the elderly, immune compromised, and those with indwelling catheters, HIV, malignancies and diabetes (19), the

frequency of which may be as high as 39% in UTI (20).

The female patients in our study (both diabetic and non-diabetic) had 100% pathogen isolate rate from their urine samples with some of the female diabetics having polymicrobial infections (38 females with 46 isolated pathogens) while all the female non-diabetics had monomicrobial infection (38 females with 38 isolated pathogens). Comparatively, the diabetic males had 59.1% (13 of 22) pathogen isolation rate while the non-diabetic males had 54.5% (12 of 22) isolation rate.

The anatomical structure of the female urogenital system, with shorter urethra and the close proximity to the anorectal region, may partly contribute to the higher pathogen isolation rates from the female patients as previously established (21). However, the study by Otajevwo (22) in an outpatient setting in Benin City, Nigeria, reported a significantly

higher prevalence rate of UTI in males (58.3%) than females (41.7%), which is contrary to the

finding of our current study and those of many others.

Table 3a: Percentage sensitivity of bacterial isolates from diabetic patients to selected antibiotics

Bacterial isolates	No	Percentage (%) of isolates sensitive to antibiotics										
		N	GN	CIP	C	OF	CF	PF	CT	AMX	ST	IMP
<b>Gram negative bacteria</b>												
<i>Proteus</i> spp	11	9.1	63.6	63.6	18.2	45.5	9.1	36.4	36.4	27.3	45.5	90.9
<i>Klebsiella</i> spp	10	0	30.0	20.0	20.0	20.0	0	50.0	30.0	0	0	90.0
<i>Escherichia coli</i>	9	33.3	66.7	44.4	33.3	44.4	22.2	44.4	44.4	22.2	44.4	88.9
<i>Pseudomonas aeruginosa</i>	7	42.9	57.1	42.9	28.6	42.9	28.6	42.9	71.4	42.9	42.9	71.4
<i>Salmonella</i> spp	6	33.3	83.3	50.0	50.0	50.0	50.0	50.0	66.7	50.0	50.0	50.0
<i>Enterobacter</i> spp	2	50.0	50.0	100.0	50.0	50.0	50.0	50.0	100.0	50.0	50.0	100.0
<i>Citrobacter</i> spp	1	0	100.0	100.0	0	100.0	0	100.0	100.0	100.0	100.0	100.0
<i>Providencia</i> spp	1	100.0	100.0	100.0	0	100.0	0	100.0	100.0	100.0	100.0	100.0
<b>Gram positive bacteria</b>												
		NB	CIP	GN	OF	CD	E	CT	AMP	CE	LV	IMP
<i>Staphylococcus aureus</i>	6	0	33.3	66.7	33.3	83.3	50.0	50.0	33.3	0	66.7	100.0
<i>Enterococcus</i> spp	6	50.0	83.3	100.0	83.3	83.3	66.7	50.0	33.3	33.3	100.0	100.0

CIP= Ciprofloxacin (10µg), CF= Cefuroxime (10µg), AMX= Amoxicillin, (30µg), C= Chloramphenicol (10µg), OF= Ofloxacin (10µg), GN= Gentamicin (10µg), E= Erythromycin (10µg), CT= Ceftriaxone (30µg), ST= Streptomycin (30µg), N= Nitrofurantoin (100µg), LV= Levofloxacin (5µg), NB= Norfloxacin (10µg), CE= Cefixime (5µg), AMP= Ampicillin/cloxacillin (30µg), IMP= Imipenem (10µg), CD= Clindamycin (10µg), PF= Pefloxacin (10µg)

Table 3b: Percentage sensitivity of bacterial isolates from non-diabetic patients to selected antibiotics

Bacterial isolates	No	Percentage (%) of isolates sensitive to antibiotics										
		N	GN	CIP	C	OF	CF	PF	CT	AX	ST	IMP
<b>Gram negative bacteria</b>												
<i>Proteus</i> spp	13	53.9	30.8	30.8	15.4	30.8	0	23.1	61.5	7.7	30.8	100.0
<i>Klebsiella</i> spp	3	66.7	100.0	100.0	66.7	100.0	33.3	100.0	100.0	33.3	66.7	100.0
<i>Escherichia coli</i>	15	66.7	40.0	33.3	20.0	20.0	0	20.0	73.3	6.7	26.7	93.33
<i>Pseudomonas aeruginosa</i>	3	66.7	33.3	66.8	33.3	33.3	0	33.3	33.3	0	33.3	100.0
<i>Enterobacter</i> spp	7	42.9	57.1	42.9	42.9	42.9	28.6	42.9	71.4	0	42.9	85.7
<b>Gram positive bacteria</b>												
		NB	CIP	GN	OF	CD	E	CT	AP	CE	LV	IMP
<i>Staphylococcus aureus</i>	5	0	20.0	0	20.0	60.0	20.0	0	0	0	60.0	100.0
<i>Enterococcus</i> spp	3	0	0	0	0	66.7	0	0	0	0	33.3	100.0
<i>Corynebacterium</i> spp	1	0	0	0	0	100.0	100.0	0	0	0	100.0	100.0

CIP= Ciprofloxacin (10µg), CF= Cefuroxime (10µg), AMX= Amoxicillin, (30µg), C= Chloramphenicol (10µg), OF= Ofloxacin (10µg), GN= Gentamicin (10µg), E= Erythromycin (10µg), CT= Ceftriaxone (30µg), ST= Streptomycin (30µg), N= Nitrofurantoin (100µg), LV= Levofloxacin (5µg), NB= Norfloxacin (10µg), CE= Cefixime (5µg), AMP= Ampicillin/cloxacillin (30µg), IMP= Imipenem (10µg), CD= Clindamycin (10µg), PF= Pefloxacin (10µg)

The most frequently isolated bacteria pathogens among the diabetic patients in our study were *Proteus* spp (18.6%), *Klebsiella* spp (16.9%) and *E. coli* (15.5%), which somewhat agrees with the study by Alebiosu et al., (23) in southwest Nigeria, which reported changing pattern of bacteriuria, with *Klebsiella* spp (42.4%) and *Proteus* spp (38.2%) accounting for the most common cause of bacteriuria among diabetics. However, bacteria isolated from the non-diabetic patients in our study were predominantly *E. coli* (30%) and *Proteus* spp (26.3%), which agrees with the study of Akinnibosun and Iriakpe (24) in Benin City, Nigeria which reported *E. coli* (44.4%) as the predominant bacteria followed by *Proteus mirabilis* (22.2%).

Among the diabetics, gentamicin, ofloxacin, imipenem and ceftriaxone were the most active antibiotics against Gram-positive and Gram-negative bacteria. Generally, resistance to cefuroxime, chloramphenicol, nitrofurantoin, norfloxacin, cefixime, and amoxicillin was high. Among the non-diabetics, imipenem was the most active antibiotics against both Gram positive and Gram-negative bacteria while resistance to norfloxacin, gentamicin, ceftriaxone, ampicillin/cloxacillin, cefixime, and cefuroxime was high. These patterns are similar to those reported by Gangoue et al., (25) in Yaounde, central Cameroon where all Gram-negative isolates were resistant to amoxicillin, with high susceptibility to ofloxacin and imipenem. The high resistance rates reported in our study also agrees with the findings of Tula et al., (26) and Khoshbakht et al., (27).

The high antimicrobial resistance (AMR) rates reported among bacterial pathogens in developing countries often result from overuse and misuse of antibiotics as a result of poor antibiotic prescribing practices by healthcare workers, and self-medication by patients and the general populace. AMR has become a public health challenge around the globe for the last few decades (28). The development of AMR in bacteria population is caused by swift evolution of bacteria genome under selective antibiotic pressure (29), and resistant mutants usually survive in environment such as hospitals where several antimicrobials are usually prescribed and infection prevention and control practices may be suboptimal. Therefore, proper use of antibiotics, especially among the vulnerable populations such as the diabetics, is highly desirable.

## Conclusion:

Although the overall frequency of isolation of bacterial pathogens in the two study populations was not significantly different, female population had a higher pathogen isolation rate than the male population, and diabetic females had a higher frequency of polymicrobial infections compared to non-diabetic female and the male population. The high antimicrobial resistance of the isolated bacteria pathogens underscores the need for clinical microbiology laboratory testings to optimize the management of UTI in diabetic patients.

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