

ANTIMICROBIAL SUSCEPTIBILITY PATTERN OF BACTERIA ISOLATED FROM URINARY TRACT INFECTION AMONG UNDERGRADUATE STUDENTS AT BENSON IDAHOSA UNIVERSITY

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ABSTRACT

Urinary tract infections (UTIs) are common among university students and are increasingly complicated by antimicrobial resistance, making effective treatment challenging. This study aimed to determine the prevalence of bacterial UTIs and the antimicrobial susceptibility patterns of isolates among undergraduate students at Benson Idahosa University. A cross-sectional study was conducted involving 120 undergraduate students. Midstream urine samples were collected aseptically and cultured on CLED and MacConkey agar to isolate uropathogens. Bacterial identification was performed using conventional biochemical tests. Antimicrobial susceptibility testing was carried out using the Kirby-Bauer disk diffusion method. Sociodemographic data and sexual activity status were collected through structured questionnaires. The overall UTI prevalence was 24.3%, with the highest rate in the 24–27 years age group. Females had a higher infection rate (25.7%) than males (13.3%), though this was not statistically significant. Sexual activity was significantly associated with UTI prevalence ($p = 0.013$). Among the 29 isolates recovered, *Staphylococcus aureus* (34.5%) was most frequent, followed by *Klebsiella* spp. (24.2%) and *Escherichia coli* (20.7%). Gram-negative isolates showed high susceptibility to gentamicin (83.3%–100%) and levofloxacin (50%–100%), but high resistance to cefixime, cefotaxime, imipenem, and cefuroxime. *S. aureus* demonstrated susceptibility to gentamicin (80%) and levofloxacin (70%) but high resistance to cefixime (90%). Multidrug resistance (MDR) was observed in 31.0% of isolates, with *E. coli* having the highest MDR rate (50%). UTIs are prevalent among undergraduate students, particularly females and sexually active individuals. The notable presence of multidrug-resistant bacteria highlights the need for continuous surveillance, rational antibiotic use, and preventive education to reduce UTI incidence and resistance development.

Keywords: Antimicrobial, Uropathogens, Midstream, Identification, Resistance.

INTRODUCTION

Urinary tract infections (UTIs), which can be identified in a lab as "significant bacteriuria," are prevalent among populations that appear to be in good health (Bigotte *et al.*, 2015). One of

the most prevalent bacterial illnesses in the world, urinary tract infections (UTIs) are prevalent in young adults, especially college students (Yarger *et al.*, 2025). Numerous behavioural, social, and physiological aspects, such as low water intake, poor hygiene habits,

sexual activity, and stress-induced immune suppression, make this population especially vulnerable. While urinary tract infections (UTIs) are more common in women, they do affect men, with approximately 12% of men experiencing at least one UTI in their lifetime. UTIs are more prevalent in older men, with incidence increasing with age, particularly after 50 (Griebing, 2005). The most prevalent pathogens linked to UTIs are bacteria, including *Escherichia coli*, *Klebsiella* species, *Proteus* species, *Staphylococcus saprophyticus*, and *Pseudomonas aeruginosa*. More than 70–80% of community-acquired UTIs are caused by the gut flora member *E. coli*, which continues to be the principal causative agent (Flores-Mireles *et al.*, 2015). But other organisms, such as gram-positive cocci like *Staphylococcus* species, have become more isolated, especially in complex cases and among young women who are sexually active (Seid *et al.*, 2023). Antimicrobial resistance (AMR) in uropathogens has alarmingly increased as a result of the extensive use and abuse of antibiotics. This presents a significant public health concern since resistant strains restrict the available effective treatments, increasing the likelihood of sequelae including pyelonephritis and urosepsis, prolonging sickness, and raising healthcare expenses. In order to direct empirical treatment and stop the establishment of multidrug-resistant strains, it is essential to comprehend the patterns of antibiotic susceptibility of bacteria isolated from UTIs. (Okeke *et al.*, 2019). The area of the urinary tract affected, the causative organisms, the severity of the infection, and the patient's capacity to generate an immune response all influence the clinical signs of UTI. Differences in definition, screening techniques, and risk variables like age, parity, and pregnancy have been blamed for variations in the incidence of bacteriuria and the ensuing UTI in various nations. Early identification of asymptomatic bacteriuria may help identify urine tract anomalies that can be corrected, lower the incidence of bacteriuria, and avoid renal scarring, obstructive atrophy, hypertension, and renal

instability. (Oscar *et al.*, 2019). UTIs can range from uncomplicated cystitis to more severe infections such as pyelonephritis and are often characterized by symptoms such as dysuria, increased frequency and urgency of urination, suprapubic discomfort, and in some cases, fever (Czajkowski *et al.*, 2021). Studying UTIs among young adults, especially undergraduate students, is of critical importance due to the unique behavioural and environmental risk factors present in this population. Factors such as increased sexual activity, poor hygiene practices, high levels of stress, inadequate hydration, and limited access to medical care contribute significantly to the risk of developing UTIs in university settings. Additionally, the practice of self-medication and misuse of antibiotics among students often exacerbates the issue, potentially leading to antibiotic resistance (McLaughlin and Carson, 2004). The study was aimed at investigating the prevalence, antimicrobial susceptibility pattern of bacteria isolates and to also determine the multiple antibiotics resistance index of the bacteria isolates from urinary tract infection among undergraduate students at Benson Idahosa University.

MATERIALS AND METHODS

Study Design

A cross-sectional design was used for this study.

Study Area

This study was conducted at Benson Idahosa University in Benin City, Edo State, Nigeria, focusing on undergraduate students. Edo State is in the South-South geo-political zone of Nigeria and lies between latitude 6° 44'N and 6°21'N and longitude 5°35'E and 5°44'E. It has a total land area of 19,281 km². The state is bordered by Delta State to the south, Kogi State to the north, Ondo State to the west, and the River Niger along the eastern border (Edo State Government of Nigeria, 2011).

Study Population

The total of one hundred and twenty (120) male and female undergraduate students from

Benson Idahosa University study were recruited for this study.

Sample Size Determination

Sample size was determined using single population proportion estimate considering the level of significances at 5% and the expected prevalence of UTI from school students from a previous study which was 7.1% (Zincir *et al.*, 2012).

N = required sample size

Z = confidence level at 95% (standard value of 1.96)

P = prevalence of UTI among school students (7.1% = 0.06)

D = margin of error at 5% (standard value = 0.05)

Minimum sample size calculated is 101. In order to account for non-response, 10% of the sample size (i.e., 10.1) will be added to the calculated sample size; this gives a sample size of 111.1, which is approximated to 120 study subjects. A total number of 120 participant was recruited for this study.

Inclusion Criteria

Undergraduate students currently enrolled at Benson Idahosa University. Students whose age were 18 and above. Students who were willing to voluntarily participate and provide informed consent. Students with or without UTI symptoms, but willing to provide urine samples. Student who was able to complete the study requirements, such as surveys and urine sample.

Exclusion Criteria

Students who were not enrolled as undergraduate students at Benson Idahosa University, students who were under 18 or over 30 years old, students who were pregnant or breastfeeding, and students who had taken antibiotics in the two weeks prior.

Ethical Approval

Approval for this research was sought from the Directorate Research Innovation Programme,

Faculty of Allied Health Sciences, Benson Idahosa University, Benin city, Edo State, Nigeria. Informed consent was also sought and obtained from all participants. A well-structured questionnaire was administered to collect bio-data and other socio-demographic information of each participant.

Sampling of Participants

Participants were recruited through random sampling methods, ensuring representative selection from the target population of undergraduate students at Benson Idahosa University. This approach helped achieve a sample that is reflective of the larger undergraduate population of Benson Idahosa University.

Sample Collection

Participants who consented to the study were provided with sterile, wide-mouthed, screw-capped universal containers for urine collection. Clear verbal and written instructions were given on how to collect a midstream clean-catch urine sample to minimize contamination. Participants were instructed to clean the external genitalia with clean water, begin urinating and discard the first part of the stream, then collect the midstream portion directly into the sterile container without touching its inner surfaces. Once collected, the samples were tightly sealed, appropriately labelled with a unique identification number, and immediately transported in a cold box to the Microbiology Laboratory at Benson Idahosa University for analysis. All samples were processed within one hour of collection to maintain specimen integrity and avoid overgrowth or contamination.

Laboratory Analysis

The urine samples collected from participants underwent a series of laboratory procedures to determine the presence of uropathogens and their antimicrobial susceptibility patterns.

Microscopic Examination

Microscopic examination was conducted to identify cellular and microbial elements. Five (5) millimetres of the urine was centrifuged at 3,000 revolutions per minute for five minutes, and the sediment was examined under a light microscope. A wet mount preparation was used to assess the presence of pus cells, red blood cells and epithelial cells. More than 5 to 10 pus cells per high power field (HPF) was considered indicative of urinary tract infection

Culture and Isolation

Each urine sample was cultured on Cystine Lactose Electrolyte Deficient (CLED) agar and MacConkey agar using a standard 0.001 mL calibrated wire loop. The plates were incubated at 37°C for 24 hours. After incubation, bacterial growth was evaluated. The morphology of the colonies, including colour, shape, and lactose fermentation ability, was also noted for preliminary identification. Mixed growth with non-significant colony counts was considered contamination and such samples were excluded from further analysis.

Isolation and Identification

Pure colonies obtained from the primary culture plates were sub-cultured on nutrient agar and subjected to a series of standard microbiological identification techniques. Gram staining was first performed to determine the Gram reaction and morphology of the organisms. Further biochemical tests were conducted based on the Gram reaction of the isolates. For Gram-negative bacilli, tests such as oxidase, indole, citrate utilization, urease and motility were done. For Gram-positive cocci, catalase and coagulase tests were conducted to distinguish between different species of *Staphylococcus* according to (Cheesbrough, 2006).

Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines. A suspension of each isolate was

prepared and adjusted to 0.5 McFarland standard turbidity. Using a sterile swab, the suspension was evenly spread across the surface of Mueller-Hinton agar plates. Commercially prepared antibiotic disks including Nitrofurantoin (300 µg), Augmentin (Amoxicillin-Clavulanic Acid) (30 µg), Levofloxacin (10 µg), Gentamicin (10 µg), Ceftriaxone (30 µg), Cefuroxime (30 µg), Cefixime (5 µg), Cefotaxime (30 µg), Imipenem (10 µg), Ofloxacin (5 µg), Ceftazidime (30 µg), and Nalidixic Acid (30 µg) were aseptically placed on the inoculated agar. The plates were incubated at 37°C for 24 hours, after which the diameter of the zones of inhibition around each disk was measured using a ruler. The results were interpreted as sensitive (S) or resistant (R) based on CLSI breakpoint values. Isolates resistant to three or more classes of antibiotics were classified as multidrug-resistant (MDR). These results were recorded and analyzed to determine the antimicrobial resistance pattern among uropathogens isolated in this study.

Statistical Analysis

Data obtained from this research were presented and analyzed using the Statistical Package for Social Sciences (SPSS) version 21.0 (IBM Inc., USA). Results were expressed in tables and charts as appropriate. The Chi-square test was used to determine if there were significant associations between categorical variables. Differences were considered statistically significant when the p-value obtained was <0.05.

RESULTS

Sociodemographic Characteristics

Out of 120 respondents who participated in the study, the response rate was 100%. The majority of the participants 84 (70.0%) were within the age group of 20–23 years, followed by 22 (18.3%) aged 16–19 years, and 14 (11.7%) aged 24–27 years. Most of the respondents were female 105 (87.5%), while only 15 (12.5%) were male, yielding a male-to-female ratio of approximately 1:7. Regarding year of study, over half of the

participants 66 (55.0%) were in their fifth year, 21 (17.5%) in their second year, 17 (14.2%) in the fourth year, 9 (7.5%) in the first year, and 7 (5.8%) in the third year. A greater proportion 95 (79.2%) were enrolled in health-related

courses, while 25 (20.8%) were in non-health-related disciplines. Concerning sexual activity, 43 (35.8%) reported being sexually active, while the majority 77 (64.2%) reported they were not (Table1).

Table 1. Sociodemographic Characteristics of Participants

Variable	Number (n=120)	Percentage (%)
Age		
16-19 years	22	18.3
20-23 years	84	70.0
24-27 years	14	11.7
Sex		
Male	15	12.5
Female	105	57.5
Year of Study		
Year 1	9	7.5
Year 2	21	17.5
Year 3	7	5.8
Year 4	17	14.2
Year 5	66	55.0
Course		
Health Related	95	79.2
Non health related	25	20.8
Sexually Active		
Yes	43	35.8
No	77	64.2

Microscopic Urine Findings

Microscopic examination of urine samples from 120 respondents revealed that the majority had no pus cells in their urine, as 83 (69.2%) were graded as "none" per high power field (HPF). Few pus cells (1–3/HPF) were observed in 33 (27.5%) of the samples, while moderate presence (4–6/HPF) was noted in only 4 (3.3%) respondents. None of the samples had numerous pus cells (>6/HPF). For epithelial cells, 30 (25.0%) of the respondents

showed no epithelial cells, 28 (23.3%) had few, 60 (50.0%) had a moderate presence, and 2 (1.7%) had numerous epithelial cells. Red blood cells (RBCs) were absent in the urine of nearly all respondents, with 118 (98.3%) showing no RBCs. Only 2 (1.7%) had moderate levels of RBCs (4–6/HPF), and none had few or numerous RBCs. These findings suggest that while pyuria was uncommon, epithelial cell shedding was relatively frequent, and haematuria was rare among the study population (Table 2).

Table 2. Qualitative Grading of Microscopic Urine Findings Among Respondents (n = 120)

Parameter	None (%)	Few (%)	Moderate (%)	Numerous (%)
Pus cells	83 (69.2)	33 (27.5)	4 (3.3)	0 (0)
Epithelia cells	30 (25.0)	28 (23.3)	60 (50.0)	2 (1.7)
Red blood cells	118 (98.3)	0 (0)	2 (1.7)	0 (0)

Note. Grading based on microscopic evaluation per high power field (HPF): None = 0/HPF; Few = 1–3/HPF; Moderate = 4–6/HPF; High = >6/HPF.

Biochemical and Morphological Identification of Bacterial Isolates

The bacterial isolates were identified based on Gram staining, microscopic morphology, and a series of biochemical tests. *Staphylococcus aureus* was the only Gram-positive organism identified, appearing as cocci and testing positive for both catalase and coagulase, but negative for motility. All other isolates were Gram-negative rods. *Escherichia coli* was lactose-fermenting, indole-positive, and motile, but tested negative for citrate and urease. *Proteus* species were catalase-positive, lactose-negative, citrate-positive, indole-negative, urease-positive, oxidase-negative, and motile. *Pseudomonas aeruginosa* was catalase-positive, coagulase-negative, lactose- and indole-negative, citrate- and oxidase-positive, and motile. *Klebsiella* species were lactose- and citrate-positive, indole-negative,

urease-positive, oxidase-negative, and non-motile (Table 3).

Prevalence of Urinary Tract Infection and Bacterial Isolates

Out of the one hundred and twenty (120) participants included in this study, twenty-nine were infected with bacteria with an overall prevalence of 24.3% (Figure 1). Out of the 29 positive urine cultures analyzed, *Staphylococcus aureus* was the most frequently isolated uropathogen, accounting for 10 (34.5%) of the total isolates. This was followed by *Klebsiella* species with 7 (24.2%) isolates, and *Escherichia coli* with 6 (20.7%) isolates. *Proteus* species were isolated in 4 (13.8%) samples, while *Pseudomonas aeruginosa* was the least frequent, identified in only 2 (6.9%) of the cases (Table 4).

Table 3: Gram's staining, Morphological and Biochemical Identification of Isolated Bacteria

Bacteria Isolated	Identification Parameters									
	GR	MM	CA	CO	LA	CI	IN	UR	OX	MO
<i>Staphylococcus aureus</i>	+	C	+	+	ND	ND	ND	ND	ND	–
<i>Escherichia coli</i>	–	R	ND	ND	+	–	+	–	ND	+
<i>Proteus</i> species	–	R	+	ND	–	+	–	+	–	+
<i>Pseudomonas aeruginosa</i>	–	R	+	–	–	+	–	–	+	+
<i>Klebsiella</i> species	–	R	ND	ND	+	+	–	+	–	–

Key: GR=Gram reaction, MM=Microscopic morphology, CA=Catalase, CO=Coagulase, LA=Lactose, CI=Citrate, IN=Indole, UR=Urease, OX=Oxidase, MO=Motility.

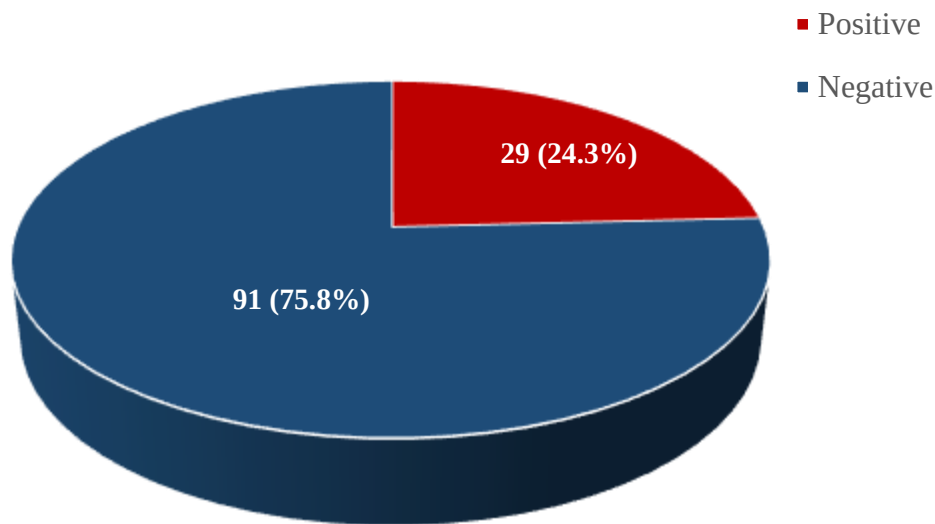


Figure 1. Prevalence of Urinary tract Infection among respondents

Table 4. Prevalence of Bacteria Species Isolated from Urine Samples

Isolates	No. of Positive Samples	Prevalence
<i>Staphylococcus aureus</i>	10	34.5
<i>Escherichia coli</i>	6	20.7
<i>Proteus</i> species	4	13.8
<i>Pseudomonas aeruginosa</i>	2	6.9
<i>Klebsiella</i> species	7	24.2
Total	29	100.0

Association Between Sociodemographic Factors and Urinary Tract Infection Prevalence

A total of 120 respondents were examined. Although there was no statistically significant association between age and UTI prevalence ($\chi^2 = 5.429$, $p = .066$), the highest infection rate was observed in the 24–27 years age group (42.9%). Sex was not significantly associated with UTI prevalence ($\chi^2 = 1.098$, $p = .295$). However, females had a higher infection rate (25.7%) compared to males (13.3%). Similarly, the year of study did not show a statistically significant relationship with UTI

prevalence ($\chi^2 = 5.679$, $p = .224$). Among all academic levels, Year 2 students had the highest prevalence (33.3%), while no cases were reported in Year 1. Course of study also did not show a significant association with UTI ($\chi^2 = 1.057$, $p = .304$), though non-health related students had a higher infection rate (32.0%) than their health-related counterparts (22.1%). Sexual activity, however, showed a statistically significant association with UTI prevalence ($\chi^2 = 6.220$, $p = .013$). Respondents who were sexually active had a notably higher rate of infection (37.2%) compared to those who were not sexually active (16.9%) (Table 5).

Table 5. Relationship Between Sociodemographic Parameters and Prevalence of Urinary Tract Infection among Respondents.

Variables	Number Examined (%)	Number Infected (%)	χ^2	P- value
Age				
16-19 years	22 (18.3)	2 (9.1)	5.429	0.066
20-23 years	84 (70.0)	21 (25.0)		
24-27 years	14 (11.7)	6 (42.9)		
Sex				
Male	15 (12.5)	2 (13.3)	1.098	0.295
Female	105 (87.5)	27 (25.7)		
Year of Study				
Year 1	9 (7.5)	0 (0)	5.679	0.224
Year 2	21 (17.5)	7 (33.3)		
Year 3	7 (5.8)	2 (28.6)		
Year 4	17 (14.2)	2 (11.8)		
Year 5	66 (55.0)	18 (27.3)		
Course				
Health Related	95 (79.2)	21 (22.1)	1.057	0.304
Non health related	25 (20.8)	8 (32.0)		
Sexually Active				
Yes	43 (35.8)	16 (37.2)	6.220	0.013*
No	77 (64.2)	13 (16.9)		

Key: p < 0.05 indicates statistical significance

Antimicrobial Susceptibility Pattern of Gram-Positive Uropathogens

The Gram-positive uropathogen isolated was *Staphylococcus aureus*. Among the antibiotics tested, *S. aureus* showed high levels of susceptibility to gentamicin (80.0%), Levofloxacin (70.0%), Azithromycin (90.0%), ciprofloxacin (70.0%), ofloxacin (60.0%), Augmentin (70%) and Erythromycin (80.0%). However, there was a high level of resistance to cefixime (90.0%), ceftriaxone, cefuroxime, and imipenem (each with 80.0% resistance) (Table 6).

Antimicrobial Susceptibility Pattern of Gram Negative Bacterial Uropathogens

The Gram-negative bacterial isolates examined in this study included *Escherichia coli*, *Proteus* spp., *Pseudomonas aeruginosa*,

and *Klebsiella* spp. These isolates showed high levels of susceptibility to gentamicin (83.3%–100%), Levofloxacin (50.0%–100%), nitrofurantoin (42.9%–100%), ofloxacin (50.0%–100%), and nalidixic acid (66.7%–100%). *Proteus* spp. and *P. aeruginosa* showed complete susceptibility (100%) to nitrofurantoin, Levofloxacin, gentamicin, cefixime, Ampiclox and nalidixic acid. *Escherichia coli* exhibited full (100%) susceptibility to ofloxacin and cefotaxime, while *Klebsiella* spp. had moderate susceptibility to most antibiotics, with resistance rates of 71.4% observed against ceftriaxone, cefixime, cefotaxime, and imipenem. High resistance among Gram-negative isolates was noted against cefixime (90%), cefotaxime (71.4%), imipenem (up to 100% in *P. aeruginosa*), and cefuroxime (up to 100% in *P. aeruginosa*) (Table 7).

Table 6. Antimicrobial Susceptibility Pattern of Gram-Positive Isolates

Antibiotics		Bacterial Isolates	
		<i>Staphylococcus aureus</i> (n=10)	
Erythromycin	S	8	(80.0)
	R	2	(20.0)
Augmentin	S	3	(30.0)
	R	7	(70.0)
Levofloxacin	S	7	(70.0)
	R	3	(30.0)
Gentamicin	S	8	(80.0)
	R	2	(20.0)
Ceftriaxone	S	2	(20.0)
	R	8	(80.0)
Cefuroxime	S	2	(20.0)
	R	8	(80.0)
Cefixime	S	1	(10.0)
	R	9	(90.0)
Cefotaxime	S	4	(40.0)
	R	6	(60.0)
Imipenem	S	2	(20.0)
	R	8	(80.0)
Ofloxacin	S	6	(60.0)
	R	4	(40.0)
Azithromycin	S	9	(90.0)
	R	1	(10.0)
Ciprofloxacin	S	7	(70.0)
	R	3	(30.0)

Table 7. Antimicrobial Susceptibility Pattern of Gram-Negative Bacterial Isolates

Antibiotics		Bacterial Isolates			
		<i>Escherichia coli</i> (n=6)	<i>Proteus spp.</i> (n=4)	<i>P. aeruginosa</i> (n=2)	<i>Klebsiella spp.</i> (n=7)
Nitrofurantoin	S	4 (66.7)	4 (100.0)	2 (100.0)	3 (42.9)
	R	2 (33.3)	0 (0.0)	0 (0.0)	4 (57.1)
Augmentin	S	4 (66.7)	3 (75.0)	2 (100.0)	5 (71.5)
	R	2 (33.3)	1 (25.0)	0 (0.0)	2 (28.4)
Levofloxacin	S	3 (50.0)	4 (100.0)	2 (100.0)	5 (71.4)
	R	3 (50.0)	0 (0)	0 (0.0)	2 (28.6)
Gentamicin	S	5 (83.3)	4 (100.0)	2 (100.0)	6 (85.7)
	R	1 (16.7)	0 (0)	0 (0.0)	1 (14.3)
Ceftriaxone	S	3 (50.0)	3 (75.0)	2 (100.0)	2 (28.6)
	R	3 (50.0)	1 (25.0)	0 (0.0)	5 (71.4)
Cefuroxime	S	4 (66.7)	3 (75.0)	0 (0.0)	2 (28.6)
	R	2 (33.3)	1 (25.0)	2 (100.0)	5 (71.4)
Cefixime	S	4 (66.7)	4 (100.0)	2 (100.0)	2 (28.6)
	R	2 (33.3)	0 (0)	0 (0.0)	5 (71.4)
Cefotaxime	S	6 (100.0)	3 (75.0)	2 (100.0)	2 (28.6)
	R	0 (0)	1 (25.0)	0 (0.0)	5 (71.4)
Imipenem	S	4 (66.7)	2 (50.0)	0 (0.0)	2 (28.6)
	R	2 (33.3)	2 (50.0)	2 (100.0)	5 (71.4)
Ofloxacin	S	6 (100.0)	2 (50.0)	2 (100.0)	4 (57.1)
	R	0 (0)	2 (50.0)	0 (0.0)	3 (42.9)
Ampiclox	S	4 (66.7)	4 (100.0)	2 (100.0)	5 (71.4)

	R	2 (33.3)	0 (0)	0 (0.0)	2 (28.6)
Nalidixic Acid	S	4 (66.7)	4 (100.0)	2 (100.0)	5 (71.4)
	R	2 (33.3)	0 (0)	0 (0.0)	2 (28.6)

Key: S=Sensitive, R=Resistant

Multiple Drug Resistance (MDR) Patterns of the Isolates

Among the Gram-positive isolate (N = 10), the overall prevalence of multidrug resistance (MDR) was 1 (10.0%) (Table 8). Among the Gram-negative isolates (N=19), the prevalence of MRD was 5 (26.3%). *Escherichia coli* had an MDR prevalence of 3 (50.0%), and

Klebsiella species had 2 (28.6%). No MDR strains were recorded for *Proteus* species or *Pseudomonas aeruginosa*. Resistance to one antibiotic (R1) was highest in *E. coli* and *Proteus* species, each showing 50.0%, while resistance to two antibiotics (R2) was observed only in *P. aeruginosa* (100.0%) (Table 9).

Table 8. Level of Antimicrobial Resistance of among Gram Positive Isolates

Bacterial Isolates	Level of Antibiotics Resistance						MDR	Total (%)
	R1 (%)	R2 (%)	R3 (%)	R4 (%)	R5 (%)			
<i>S. aureus</i>	1 (10.0)	2 (20.0)	3 (30.0)	2 (20.0)	1 (10.0)		1 (10.0)	10 (100.0)

Key; R0 – susceptible to all antibiotics, R1–resistance to one antibiotic, R2–resistance to two antibiotics, R3–resistance to three antibiotics, ≥ R4–resistance to four and above antibiotics, MDR–multidrug resistant: non-susceptible to at least one agent in three antimicrobial categories. Based on this definition, the following antimicrobial categories were considered to determine whether the given isolate is MDR isolates: Macrolides (Erythromycin), aminoglycosides (gentamicin), cephalosporin (ceftriaxone), beta lactam (augmentin), fluoroquinolones (ofloxacin) and carbapenem (imipenem).

Table 9. Level of Antimicrobial Resistance among Gram Negative Isolates

Bacterial Isolates	Level of Antibiotics Resistance						MDR	Total (%)
	R1 (%)	R2 (%)	R3 (%)	R4 (%)	R5 (%)			
<i>Escherichia coli</i>	3 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)		3 (50.0)	6 (100.0)
<i>Proteus species</i>	2 (50.0)	0 (0.0)	0 (0.0)	2 (50.0)	0 (0.0)		0 (0.0)	4 (100.0)
<i>P. aeruginosa</i>	0 (0.0)	2 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)		0 (0.0)	2 (100.0)
<i>Klebsiella species</i>	2 (28.6)	0 (0.0)	0 (0.0)	1 (14.3)	2 (28.6)		2 (28.6)	7 (100.0)

Key; R0 – susceptible to all antibiotics, R1–resistance to one antibiotic, R2–resistance to two antibiotics, R3–resistance to three antibiotics, ≥ R4–resistance to four and above antibiotics, MDR–multidrug resistant: non-susceptible to at least one agent in three antimicrobial categories. Based on this definition, the following antimicrobial categories were considered to determine whether the given isolate is MDR isolates: Nitrofurantoin (nitrofurantoin), aminoglycosides (gentamicin), cephalosporin (ceftriaxone), beta lactam (augmentin), fluoroquinolones (ofloxacin), carbapenem (imipenem) and quinolone (nalidixic acid).

DISCUSSION

Urinary tract infections (UTIs) remain one of the most common bacterial infections affecting individuals globally, with young adults, especially females, being particularly susceptible due to behavioral, anatomical, and physiological factors (Elorfaly, 2024; Finer and Landau, 2004). This study investigated the prevalence and antimicrobial susceptibility patterns of bacterial pathogens isolated from UTIs among undergraduate students at Benson Idahosa University.

The predominance of respondents aged 20–23 years aligns with the typical age range of undergraduate students and reflects the social and academic dynamics at this stage of life. The high female participation, with a ratio of about 7:1, is expected given females' greater susceptibility to UTIs (Dias *et al.*, 2022). The larger number of students in senior years and health-related courses may suggest greater awareness or interest in health topics, which could influence their willingness to participate (Gazibara *et al.*, 2024). It was observed that only about a third of participants reported

being sexually active, which is an important consideration since sexual activity is a known risk factor for UTIs (Vincent *et al.*, 2013). This low rate could be due to cultural factors or underreporting. Similar demographic patterns have been observed in other studies among university students, confirming the gender and age trends commonly associated with UTIs, though sexual activity rates can vary depending on cultural factors (Ayoade *et al.*, 2013).

The overall prevalence of urinary tract infection (UTI) among the select undergraduate students at Benson Idahosa University was found to be 24.3%, indicating that nearly one in four students were affected by bacterial UTIs. This moderate prevalence may be influenced by various factors, including age, gender distribution with predominance of females and sexual activity unique to the university setting. When compared to other studies, this prevalence is considerably lower than the 90.1% reported in a 2018 Ethiopian study which involved a broader outpatient population suspected of UTI and utilized advanced identification methods (Seifu and Gebissa, 2018). Similarly, the 50% prevalence reported among symptomatic students at Ahmadu Bello University Sick-bay (Bishop and Shehu, 2016) and the 77.3% prevalence in Delta State university students (Otajevwo and Eriagbor, 2014) were higher, likely due to inclusion of symptomatic individuals. In contrast, the 14.5% prevalence found among female students at Babcock University (Ajani *et al.*, 2020) are closer to the current study's findings which may be due to the fact that both studies recruited asymptomatic participants. However, similar prevalence (25%) has also been observed in a study involving symptomatic participants by Ayoade *et al.* (2013) among Redeemer's University students. The microscopic urine examination showed that most participants had no or very few pus cells, indicating that active inflammation or infection was relatively uncommon in this population. The low presence of pyuria aligns with the moderate

prevalence of UTIs observed, suggesting many participants may have had asymptomatic or mild infections (Bilsen *et al.*, 2023). Epithelial cells were moderately present in half of the samples, which could reflect normal shedding of urinary tract lining cells or minor irritation rather than infection (Birder and Andersson, 2019). The near absence of red blood cells suggests haematuria was rare, indicating limited tissue damage or trauma in the urinary tract among respondents (Akiboye and Sharma, 2019).

The etiologic agents isolated in this study revealed *Staphylococcus aureus* as the predominant uropathogen. This finding contrasts with the broader literature, where Gram-negative bacteria, particularly *Escherichia coli*, are typically the dominant causes of urinary tract infections (CLSI, 2005). However, the prominence of *S. aureus* aligns with some Nigerian studies; for example, Otajevwo and Eriagbor (2014) similarly reported *S. aureus* as the most frequent isolate. In contrast, many other studies in Africa consistently identify *E. coli* as the leading uropathogen (Seifu and Gebissa, 2018; Ayoade *et al.*, 2013; Alemu *et al.*, 2012). Variations in isolation rates may be influenced by differences in study populations, sample sizes, or diagnostic techniques. The established pathogenicity of *E. coli* in UTIs is linked to its virulence factors that promote urinary tract colonization (Kabew *et al.*, 2013). The detection of *Klebsiella* species in this study aligns with the study of Seifu and Gebissa (2018). The clinical significance of *Klebsiella* lies in its association with multidrug resistance and complicated urinary infections. The presence of *Proteus* species aligns with regional studies where it is less prevalent than primary uropathogens but remains a recognized cause of UTIs. *Pseudomonas aeruginosa* was the least commonly isolated organism, consistent with its generally low prevalence in similar studies from Nigeria (Ayoade *et al.*, 2013). This likely reflects its typical role as an opportunistic pathogen associated with complicated or hospital-acquired infections.

In this study, although age was not significantly associated with UTI, the highest infection rate occurred among those aged 24–27 years. This may reflect higher levels of sexual activity or behavioral risk factors common in this age group. No significant relationship was found between sex and UTI prevalence, but females recorded a higher infection rate than males, which aligns the study of Otajevwo and Eriagbor, 2014 and is likely due to anatomical differences such as a shorter urethra and proximity to the anus, predisposing females to bacterial colonization. The year of study and course of study also showed no statistically significant relationships with UTI prevalence, although Year 2 students and non-health-related students had higher infection rates. This may be attributed to increased academic or lifestyle stress in the second year or possibly reduced health awareness among non-health students. Sexual activity was the only variable with a statistically significant association with UTI prevalence. Sexually active respondents had a significantly higher rate of infection, a finding consistent with numerous studies that recognize sexual intercourse as a major risk factor for UTIs. This aligns with the finding of Gebremariam *et al.* (2019) and may be due to frequent use of contraceptives in addition to having frequent intercourse which can push the bacteria into the bladder as explained above (Emiru *et al.*, 2013).

The antimicrobial susceptibility pattern in this study revealed varied responses among Gram-negative and Gram-positive uropathogens. Gram-negative bacteria, including *E. coli*, *Proteus* spp., *P. aeruginosa*, and *Klebsiella* spp., generally showed high susceptibility to gentamicin, Levofloxacin, ofloxacin, nitrofurantoin, and nalidixic acid, aligning with previous findings from Nigeria and Bangladesh (Nsofor *et al.*, 2016; Yusuf *et al.*, 2015). *Proteus* spp. and *P. aeruginosa* showed complete susceptibility to several antibiotics, which could be attributed to their lesser exposure to empirical treatments in the study area. In contrast, a high level of resistance was observed to cefixime, cefotaxime, imipenem,

and cefuroxime, particularly in *P. aeruginosa* and *Klebsiella* spp., consistent with earlier studies reporting rising resistance to beta-lactam antibiotics (Emiru *et al.*, 2013; Kabew *et al.*, 2013). This resistance may stem from beta-lactamase production and overuse or misuse of these antibiotics. Among Gram-positive isolates, *Staphylococcus aureus* demonstrated good susceptibility to gentamicin and fluoroquinolones like levofloxacin and ofloxacin but was highly resistant to cephalosporins and augmentin, echoing patterns observed in similar Nigerian studies (Nsofor *et al.*, 2016). The high resistance of *S. aureus* to beta-lactam antibiotics (Augmentin, Ceftriaxone, Cefuroxime, Cefexime, Cefotaxime and Imipenem) could be due to the widespread presence of beta-lactamase-producing strains or methicillin-resistant variants.

This study found a 31% overall prevalence of multidrug resistance (MDR) among bacterial uropathogens, with *Staphylococcus aureus* and *Escherichia coli* showing the highest rates. No MDR was detected in *Proteus* species or *Pseudomonas aeruginosa*. Compared to previous studies by Alabi *et al.* (2014), this MDR rate is lower. Variations likely reflect differences in antibiotic use, stewardship, and study conditions. Despite the lower rate, MDR in key pathogens remains a significant concern.

CONCLUSION

The overall prevalence of UTI in this study was 24.3%. Sexual activity showed a statistically significant relationship with infection. *Staphylococcus aureus* was the most common isolate, followed by *Klebsiella* spp. and *Escherichia coli*. Most isolates showed high susceptibility to gentamicin, Levofloxacin, nitrofurantoin, and ofloxacin, while notable resistance was observed against cefixime, ceftriaxone, cefuroxime, and imipenem. Multidrug resistance (MDR) was present in 31% of isolates. These findings highlight a concerning presence of UTI and antibiotic resistance among university students, emphasizing the need for targeted

interventions such as promoting safe sexual practices and rational antibiotic use to reduce UTI burden and resistance development.

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