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Research Article

Comparative Analysis of Etiologic Agents, Associated Risk Factors, and Antibiotic Susceptibility Pattern of Urinary Tract Infections Among Reproductive-Age Females Attending the Logbaba District Hospital, Douala, Cameroon

Ambe Fabrice Ngwa[1-3]*, Ekwi Damian Nsongmayi[4], Sirri Kelley Ambe[3], Tanyi Pride Bobga[1,2], Bertrand Ngwa Sangwe[6], Bih Vanessa Tita[3,6] and Ebai Christabel Ashu[5]

[1]*Department of Microbiology and Parasitology, Faculty of Science, University of Buea, Cameroon*

[2]*Department of Medical Laboratory Sciences, Faculty of Health Sciences, University of Buea, Cameroon*

[3]*School of Medical and Biomedical Sciences, Fomic Polytechnic University, Buea, Cameroon*

[4]*Department of Biomedical and Medical Sciences, Faculty of Science, University of Ebolowa, Cameroon*

[5]*Department of Public Health, Faculty of Medicine and Pharmaceutical Science, University of Douala, Cameroon*

[6]*Department of Public Health, Faculty of Health Sciences, University of Bamenda, Cameroon*

***Corresponding Author:** Ambe Fabrice Ngwa, Department of Microbiology and Parasitology, Faculty of Science, University of Buea, Cameroon.

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Abstract

Background: This study assessed the etiologic profile, antibiotic susceptibility pattern, and associated risk factors of UTIs among reproductive-age females attending the Logbaba District Hospital, Douala.

Methods: A cross-sectional study was conducted from January to July 2023, recruiting 259 females using convenient sampling. Sociodemographic and risk factors information was obtained using a structured questionnaire. Mid-stream urine samples were cultured on Cystine Lactose Electrolyte Deficient media, and isolates were identified using API 20. Antibiotic sensitivity testing was performed using a modified Kirby-Bauer susceptibility testing technique. The multivariate logistic regression model was used to examine factors associated with UTIs (p-value < 0.05 was considered significant).

Results: The overall prevalence of UTIs among reproductive-age females was 82/259 (31.66%). Ages ranging from 21 - 30 years (AOR: 2.53, 1.32 - 4.43, p = 0.006) and 31 - 40 years (AOR: 0.19, 0.14 - 0.54; p < 0.0001), student (AOR: 1.8, 1.21 - 2.75; p = 0.010), history of UTI (AOR: 5.34, 1.86 - 18.15; p = 0.03), symptomatic (AOR = 2.86, 1.78 - 4.67, p <0.0001) and secondary education (AOR: 0.13, 0.08 - 0.32; p < 0.0001) were predictors to UTI. *Klebsiella Pneumoniae* was the most frequent species 27 (32.9%), followed by *E coli* 22(26.8%), *Staphylococcus aureus* 16 (19.5%), CONS 8 (9.8%), *Proteus mirabilis* 6 (7.3%) and *Pseudomonas aeruginosa* 3(3.7%). Majority of the isolates were sensitive to Cefotaxime (87.80%), Imipenem (85.7%), Ofloxacin (76.83%), Ceftriaxone (75.61%), Ciprofloxacin (74.39%), Gentamicin (71.95%) and Doxycycline (69.51%), but resistant to Amoxicillin (51.22%), cotrimoxazole (47.56%) and Erythromycin (31.71%). All the isolates showed multidrug resistance (100%), and *Klebsiella Pneumoniae* and *E coli* were the most multidrug resistant species.

Conclusion: The high prevalence of UTIs and multidrug-resistant strains highlights the need for targeted antimicrobial selection to improve treatment outcomes in this population.

Keywords: Etiologic Agents; Antibiotic Susceptibility; Reproductive Age Females; Risk Factors; Urinary Tract Infection (UTI); Logbaba District Hospital

Abbreviations

AOR: Adjusted Odd Ratio; CI: Confident Interval; COR: Crude Odd Ratio; UTI: Urinary Tract Infection; MDR: Multiple Drug Resistant; OR: Odd Ratio; WHO: World Health Organization; CONS: Coagulase Negative Staphylococcus.

Background

Urinary tract infections (UTIs) are one of the most common human infections faced by clinicians working in the developing world and also the most frequent bacterial infections in the human urinary system [1,2]. Most of these infections involve the lower urinary tract, namely the bladder and the urethra. Most studies report that gram-negative bacteria cause more than 50% of urinary tract infections UTIs [3,4], while gram-positive bacteria account for a few cases [5]. The most frequently isolated uropathogen is *Escherichia coli*, accounting for 65% to 90% of UTIs, followed by *Klebsiella pneumoniae*, *Staphylococcus saprophyticus*, *Enterococcus faecalis*, *Proteus mirabilis*, and group B Streptococcus (GBS) [4,6]. Nowadays, UTIs represent a serious public health problem and affect around 405 million people globally, and nearly 0.23 million people died of UTIs, contributing to 5.2 million disability-adjusted life years (DALYs) in 2019 [7]. The prevalence of urinary tract infections (UTIs) in Africa varies widely, with sub-Saharan Africa facing a disproportionately high burden due to factors such as limited healthcare access, poor sanitation, and socioeconomic challenges. In East Africa, for example, studies in Eastern Uganda show a UTI prevalence of up to 29.6% among women [8], In the Northern Region of Ghana UTIs account for 39.8 of infections in pregnant women [9], and in South Africa, the prevalence in women is 50%, with socio-economic factors playing a significant role [10].

Women have a greater risk of developing UTIs than men because of the short, straight anatomy of the urinary tract, and the proximity to the vagina and anus, along with the absence of bactericidal prostatic secretion and moist anal canal region, thus facilitating infection [11]. Sexual intercourse also facilitates the ascent of bacteria into the bladder and the increase in the uterus weight as it grows and blocks the drainage of urine from the bladder, thus causing urinary stasis, which leads to infection of the urinary tract [6]. Typical symptoms of UTIs include frequency of urination, dysuria, urgency, nocturia, suprapubic pain, hematuria, malaise, vague or mild abdominal pain, and incontinence [12]. Also, several factors such as poor antenatal care access, increased sexual activity, pregnancy, infants, elderly, and hospitalization status, previous history of UTIs, and inadequate hygiene practices are significant contributors to the prevalence of these infections [13-15]. For example, improper wiping techniques can facilitate bacterial introduction into the urinary tract, while women with a history of UTIs are at higher risk for recurrence [16]. Recurrent Urinary tract infections and asymptomatic UTIs in reproductive-age females are associated with sexual dysfunction leading to deterioration of overall life quality, cystitis and pyelonephritis, and Pelvic inflammatory disease [17]. Also, an untreated and repeated UTI infection in reproductive-age females can affect the overall reproductive health, including the ovulation process, which is a serious health issue nowadays in our communities and is associated with infertility as a result of pelvic inflammatory disease. Early detection and prompt treatment are crucial to prevent the possibility of evolving to further complexity of UTI.

In Cameroon, 4.95 million people died in 2019 from drug-resistant infections, and AMR directly caused 1.27 million of those deaths [18]. One in five of those deaths occurred among children under 5 years old [18]. In Cameroon, routine culture and antimicrobial susceptibility testing of UTIs are not frequently performed, and the treatment is on an empirical basis [4]. Research has shown that common uropathogens, particularly *E. coli*, exhibit alarming resistance patterns to frequently prescribed antibiotics such as amoxicillin and trimethoprim-sulfamethoxazole [15,19]. This resistance complicates treatment options and highlights the need for regular surveillance of antibiotic susceptibility patterns to inform empirical therapy. The reliance on syndromic management due to limited laboratory capacity for culture and sensitivity testing further exacerbates this issue, often leading to ineffective treatment regimens and increased morbidity associated with recurrent infections [20,21]. Particularly in the developing world, where there is a high level of poverty, illiteracy and poor hygienic practices, there is also a high prevalence of fake and spurious drugs of questionable quality in circulation. A study by Mouiche., *et al*. [22] reported a 68.2% rate of antimicrobial resistance among humans in Cameroon.

A similar study conducted in the Buea Health District by Ngong., *et al*. [4], reported 31% UTI prevalence among pregnant women, and in Douala, by Dorgelesse., *et al*. [23], revealed a prevalence of 32.2% of UTI among Cameroonians under five children, and also Egbe., *et al*. [24], reported a higher prevalence of uropathogens among pregnancy and maternal-fetal outcomes at the Douala Referral Hospital, Cameroon: However, to our knowledge, there are few published data on the etiology agents and antibiotic susceptibility of UTI among reproductive-age females in Cameroon. Thus, this study aims to determine the bacterial profile, antibiotic sensitivity and risk factors of UTIs among reproductive-age females attending the Logbaba District Hospital, Douala.

Materials and Methods

Study area

This study was carried out at the Logbaba District Hospital, located in Douala, Wouri Division, Littoral region. Douala is a cosmopolitan town with a population of over a million and the hospital received more than fifteen thousand patients per annum. This hospital consists of seven main units which are; Radiology, Surgery, Cardiology, Pediatric, Emergency, Intensive Care Unit and the Medical Laboratory.

Study design

This was a hospital-based cross-sectional study carried out between January 2023 to July 2023. At enrolment, informed consent was obtained from each participant. Data on the symptoms of UTIs, demographic characteristics, medical history and information on the risk factors tested were obtained using a questionnaire.

Study population

All reproductive-age females attending the Logbaba District Hospital who agreed to participate by signing the informed consent form were included in the study. Also, reproductive-age females with painful sensations during urination and urine frequency were included in this study. Reproductive-age females who were on antibiotics or had taken any within the previous weeks, as well as those who refused to give consent, were excluded from the study.

Sample size determination

The sample size of 259 was arrived at by use of the Lorenz formula; $n = z^2p(1-p)/d^2$, where z = Z score for 95% confidence interval = 1.96, p = prevalence, and d = acceptable error (5%). We used the prevalence of UTIs among non-pregnant women in Harar, Eastern Ethiopia, of 8.9% [25].

Ethical consideration

Ethical review and clearance were obtained from the Institutional Review Board (IRB/FHS UB) (2023/2903-01/UB/SG/IRB/FHS) and administrative clearance from the Regional Delegation of Public Health and the director of the Logbaba District Hospital.

Study procedure

Urine specimen collection for culture

Midstream urine sample was collected in sterile clean leak-proof bottles from each patient. To avoid contamination of the specimen, all participants were required to first clean the urethral area with a castile soap towelette. In addition, female participants were required to open widely the labia apart before sample collection.

Laboratory analysis

Urinalysis

The colour and consistency of freshly collected urine samples were recorded. A Combii 11 dipstick (URIT Medical Electronic Co-LTD, China) was used for urinalysis. The strip contained the following analytes; ascorbic acid, specific gravity, pH, ketone, glucose, urobilinogen, bilirubin, nitrite, leucocytes, blood and proteins. The reagent strip pad was completely immersed in fresh urine, and observed for colour changes. These were read against the colour chart on the labelled test strip container and the results were recorded.

Culture

Cystine-Lactose-Electrolyte-Deficient (CLED) and Mueller Hilton were prepared according to the manufacturer’s instructions. Sterile urine samples were examined microscopically to detect significant pyuria. Ten microliters (10 µL) of each sample were streaked on the media (CLED) and incubated at 37 °C for 18 – 24 h, after which the number of colonies on each plate was recorded. Only samples with bacterial count $\geq 10^5$ colony forming unit (CFU) per mL of urine were considered positive. Culture isolated with two or more bacteria was considered as mixed flora that may be due to contamination [26]. All positive cultures were then identified at the species level by their colony characteristics, gram-staining reaction and biochemical testing using the standard microbiological technique (colony characteristics, gram staining and biochemical testing). Gram-positive cocci were identified using catalase and coagulase tests while for the gram-negative bacilli, oxidase test, catalase test and API20E were used for species identification.

Antibiotic susceptibility

Antibiotics that are commonly prescribed and are mostly used for empirical treatment in Cameroon were selected for antibiotic susceptibility tests. Antimicrobial susceptibility of pure isolates to antibiotics (Cypress Diagnostics, Italy); Vancomycin, Tetracycline (30μg), Imipenem, Gentamicin (20μg), Cefotaxime (30μg), Erythromycin (15 μg), Ceftriaxone (30μg), Ciprofloxacin (5μg), Doxycycline, Ofloxacin, Trimethoprim-sulfamethoxazole (25μg) and Amoxicillin (20 μg), were performed by Kirby-bauer disc diffusion method on Mueller-Hinton agar as described by Clinical and Laboratory Standards Institute guidelines [27]. The plates with the discs were incubated for 18 - 24 h at 35 ± 2°C and the zone of inhibition was measured in millimeters. The zone of inhibition around the discs was measured in triplicate with a transparent ruler and interpreted according to the NCCLS guidelines [27]. MDR was evaluated as resistance to ≥1 drug in ≥3 antimicrobial categories (e.g., β-lactams, aminoglycosides, fluoroquinolones).

Quality control

Routine sterility testing of the media was performed by placing 5% of the batch in the incubator at 37°C overnight and checking for the presence of turbidity in a fluid medium and the presence of growth in solid media. Standard strains of American-type culture collection (ATCC) of *E. coli* (ATCC 25922) and *S. aureus* (ATCC 25923) were used to check the performance of the media and biochemical tests.

Data analysis

Data were recorded on register and entered into a Microsoft Excel 2010 data base in a secure computer and analysis was done with Statistical Package for the Social Sciences (SPSS)version 20. Data was statistically described in terms of percentage. The Chi-square test was applied to analyze associations of UTI infections with sociodemographic factors. Multivariate analysis was applied to analyze risk factors associated with UTIs. P-values less than 0.05 were considered statistically significant at a 95% confidence interval.

Results

Sociodemographic factors of reproductive - age females attending the Logbaba District Hospital

Two hundred and fifty-nine (259) reproductive-aged females between 18 – 43 years were involved in this study. The mean age of the participants was 23.2 ± SD (6.56), and the median age was 24. Ninety-six (36.3%) of the participants were 21-30 years and 31-40 years, each. More than half (55.2%) of the participants were married. The majority (78.8%) of the participants attained secondary school, 14.7% attained primary school and 6.6% attained university. A majority (41.3%) of the participants were housewives (Table 1).

Variables	Frequency	Percentage ± SE (%)
Age/year		
≤20	26	10.0 ± 3.73
21-30	94	36.3 ± 4.88
31-40	94	36.3 ± 3.88
<40	45	17.4 ± 4.45
Occupation		
Business	43	16.6 ± 4.53
Employed	32	12.4 ± 2.11
House wife	107	41.3 ± 3.00
Student	77	29.7 ± 2.54
History of infection		
No	115	44.4 ± 3.56
Yes	144	55.6 ± 4.06
Douching after intercourse		
No	131	50.6 ± 3.77
Yes	128	49.4 ± 4.07
Marital status		
Married	143	55.2 ± 4.06
Single	116	44.8 ± 3.76
Parity		
Multiparous	133	51.4 ± 3.08
Nulliparous	63	24.3 ± 4.23
Uniparous	63	24.3 ± 5.23
Education		
Primary	38	14.7 ± 4.36
Secondary	204	78.8 ± 4.99
University	17	6.6 ± 2.96
Type of toilet used		
Bucket	59	22.8 ± 4.15
Pit	99	38.2 ± 5.90
Water cistern	101	39.0 ± 3.95

Is the toilet personal or shared		
Personal	130	50.2 ± 6.08
Shared	129	49.8 ± 6.08
Symptoms		
Absent	158	61.0 ± 5.95
Present	101	39.0 ± 5.95
Use of contraceptives		
No	119	45.9 ± 6.07
Yes	140	54.1 ± 6.07
Total	259	100.0

Table 1: Sociodemographic characteristics of reproductive age females attending the Logbaba District Hospital.

Prevalence of UTI's among reproductive-age women attending the Logbaba District Hospital

Out of the 259 reproductive - age women screened for UTI's, 82 were positive for UTI's given a prevalence of 31.66% (Figure 1).

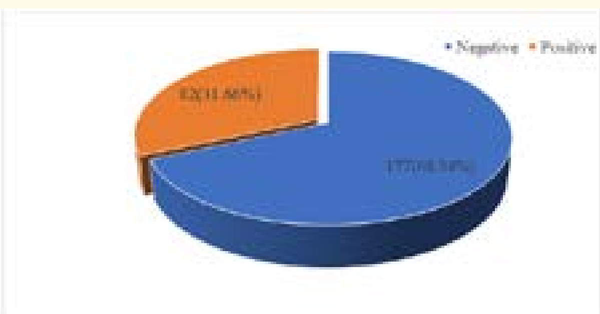

Figure 1: Prevalence of UTI amongst reproductive-age females attending the Logbaba District Hospital.

Crosstabulation of the prevalence of UTIs according to sociodemographic characteristics

Reproductive-age females within the age range ≥20, 21–30 and 31–30 years recorded a decreasing UTI positivity of 12 (46.15%),28 (29.79%) and 28 (29.79%), respectively, and there was a significant association (p = 0.04) between infection rate and age. Out of one hundred and fifty-six (156) participants with a history of UTIs, 52 (28.7%) were positive for bacteriuria (Table 2). Also, a history of UTI was significantly associated (p = 0.04) with the prevalence of UTI. Also, of the number of subjects diagnosed with UTIs, 8(47.05%) attained the tertiary level of education, 62(30.39%) secondary level, and 12 (31.58%) attained primary level education, and educational level was positively associated (p = 0.018) with the prevalence of UTI. On the other hand, the type of toilet used (p = 0.006) and Symptoms (p = 0.02) were significantly related to the prevalence of UTI. Participants that used a water cistern and those that have symptoms reported a positivity of 34 (34.34%) and 50 (41.32%), respectively (Table 2).

Risk factors associated with Urinary tract infection among reproductive-age females

In bivariable analysis, age range between 21 - 30 years and 31 - 40 years, presence of symptoms, urinary frequency, education (secondary), usage of water cistern toilets, previously infected with UTI and being a student were predictors of UTI (Table 3). Variables with p-value ≤0.25 were subjected to multivariate analysis. The multivariate analysis reveals that reprodctive - age females between the ages of 21 - 30 and 31 - 40 years were 2.53 (95% CI 1.32 - 4.43, p = 0.006) and 0.19 (95% CI: 0.14 - 0.54; p <0.0001) times, respectively, likely to suffer from UTI. Also, reproductive-age females who were students were 1.8 times associated with

Variable		**UTI**		**Chi square**	**P- value**
Negative		**Positive**			
n (%)		**n (%)**			
Age/year	≤20	14(53.85)	12(46.15)	17.1	0.03
	21-30	66(70.21)	28(29.79)		
	31-40	66(70.21)	28(29.79)		
	<40	31(68.89)	14(31.11)		

Occupation	Business	29(67.44)	14(32.66)	4.064	0.247
	Employed	21(66.67)	11(33.33)		
	House wife	80(74.77)	27(25.23)		
	Student	47(61.04)	30(38.96)		
History of infection	No	73(63.48)	30(36.52)	10.31	0.04
	Yes	104(69.44)	52(30.56)		
Douching after inter-course	No	89(67.94)	42(32.06)	.020	.497
	Yes	88(68.75)	40(31.25)		
Marital status	Married	108(75.52)	35(24.48)	7.617	0.004
	Single	69(59.48)	47(40.52)		
Parity	Multiparous	94(70.68)	39(29.32)	1.607	0.469
	Nulliparous	39(61.90)	24(38.10)		
	Uniparous	44(69.84)	19(30.16)		
Education	Primary	26(68.42)	12(31.58)	3.616	0.018
	Secondary	142(69.61)	62(30.39)		
	University	9(52.94)	8(47.05)		
Type of tiolet used	Bucket	45(76.27)	14(23.73)	8.025	0.006
	Pit	65(65.66)	34(34.34)		
	Water cistern	65(65.66)	34(34.34)		
Symptoms	Absent	106(76.81)	32(23.19)	13.16	0.02
	Present	71(58.68)	50(41.32)		
Use of contraceptives	No	82(68.91)	37(31.09)	.033	0.482
	Yes	95(67.86)	45(32.14)		
Total		177(68.34)	82(31.66)		

Table 2: Crosstabulation of the prevalence of UTI's according to sociodemographic characteristics.

UTI (95% CI: 1.21 - 2.75; p = 0.010). However, those who had previously experienced a UTI had five times the odds of getting one compared to those who had never had one (AOR = 5.34, 95% CI = 1.86 - 18.15; p = 0.03). Urinary frequency symptoms were found to be statistically significantly associated with UTI (AOR: 5.58, 95%CI: 2.13 - 13.30; p = 0.001), and subjects with symptoms were three times more positively and significantly associated with UTI (AOR = 2.86, 95% CI 1.78 - 4.67; p < 0.0001). More significantly, those who use water cistern toilets were 3.52(1.38 - 9.38; p = 0.011) times more likely to get a UTI. Education (secondary) (AOR: 0.13, 95% CI 0.08 - 0.32; p < 0.0001), was found to be an independent risk factor for UTI in reproductive-age females (Table 3).

Variable		**Prevalence of Urinary infections**			
COR (95% CI)		**P-value**	**AOR (95%CI)**		**P-value**
Age/year	≤20	1		1	
	21-30	0.372 (0.14 - 0.96)	0.043	2.53 (1.32 – 4.43)	0.006
	31-40	0.24 (0.17 - 0.49)	<0.0001	0.19 (0.14–0.54)	<0.0001
	<40	0.41 (0.092 - 1.804)	0.24	3.12 (0.77 - 13.36)	0.111

Occupation	Business	1		1	
	Employed	1.73 (0.15–13.82)	0.621	3.23 (0.81–10.34)	0.052
	House wife	2.37 (0.54 - 12.45)	0.167	2.42 (0.75 - 11.83)	0.085
	Student	1.73 (1.12 - 2.64)	0.016	1.8 (1.21 - 2.75)	0.010
History of UTI	No	1		1	.
	Yes	3.09 (1.15 - 12.18)	0.00	5.34 (1.86 - 18.15)	0.003
Douching after intercourse	No	1		1	
	Yes	1.08 (0.68–1.73)	0.809	1.28 (0.67–1.76)	0.814
Urinary frequency	No	1		1	
	Yes	2.9 (1.72 - 4.922)	0.00	5.58 (2.13 - 13.30)	0.001
Marital status	Single	1		1	
	Married	2.07 (0.23 - 18.53)	0.52	0.538 (0.06 - 5.12)	0.590
Parity	Nulliparous	1		1	
	Uniparous	0.968 (0.365 - 2.566)	0.948	0.573 (0.159 - 2.070)	0.396
	Multiparous	0.521 (0.142- 1.52)	0.250	0.916 (0.267- 3.151)	.890
Education	Primary	1		1	
	Secondary	0.15 (0.09 - 0.26)	<0.0001	0.13 (0.08 - 0.32)	<0.0001
	University	0.48 (0.19 - 1.21)	0.092	3.67 (0.46–15.51)	0.058
Type of tiolet used	Bucket	1		1	
	Pit	1.73 (1.12 - 2.64)	0.016	1.28 (0.67 - 1.76)	0.814
	Water cistern	3.4 (1.85 - 6.6)	0.000	3.52(1.38 - 9.38)	0.011
Symptoms	Absent	1		1	
	Present	2.76 (1.73 - 4.44)	<0.0001	2.89 (1.78 - 4.67)	<0.0001
Use of contraceptives	No	1		1	
	Yes	0.82 (0.15 - 4.40)	0.309	1.40 (0.49 - 4.0])	0.53

Table 3: Risk factors associated with Urinary tract infection among reproductive age females.

Frequency of bacteria identified and antibiotic susceptibility pattern of UTI's isolates

Frequency of UTI isolates identified

In the total 82 samples that yielded growth of bacteria causing UTIs, single species were grown on all the samples. *Klebsiella Pneumoniae* was the most frequent species 27 (32.9%), followed by *E coli* 22(26.8%), *Staphylococcus aureus* 16 (19.5%), CONS 8 (9.8%), *Proteus mirabilis* 6 (7.3%) and *Pseudomonas aeruginosa* 3(3.7%) (Figure 2). Gram-negative bacterial isolates were more prevalent than Gram-positive bacterial isolates (70.7% vs 29.3%).

The antibiotic sensitivity pattern of UTI's Isolates

We investigated the antibiotic susceptibility pattern of the 82 bacterial isolates as shown in Table 4. The majority of the isolates were sensitive to cefotaxime (87.80%), followed by imipenem (85.7%), Vancomycin (79.27%), Ofloxacin (76.83%), Ceftriaxone (75.61%), Ciprofloxacin (74.39%), Gentamicin (71.95%) and Doxycycline (69.51%). Amoxicillin (51.22%), cotrimoxazole (47.56%), Erythromycin (31.71%) and Tetracycline (21.95%) were the most resistant antibiotics, respectively (Table 4) (Figure 3,4).

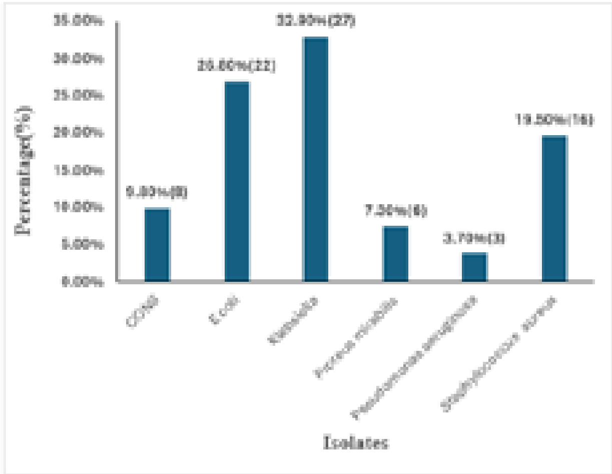

Figure 2: Frequency of UTI Isolates Identified.

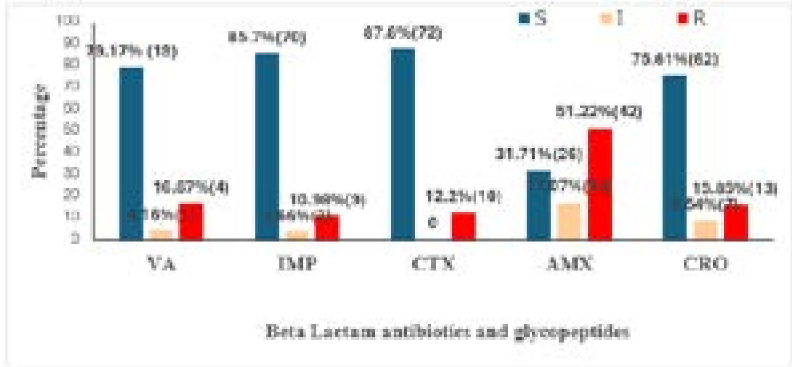

Figure 3: Antibiotic susceptibility pattern of β-lactam antibiotics and glycopeptides to UTI isolates.

Antibiotics tested													
Bacteria Isolates	**Suscepti-bility**	**VA n(%)**	**TET n(%)**	**IMP n(%)**	**CN n(%)**	**CTX n(%)**	**ERY n(%)**	**CRO n(%)**	**CIP n(%)**	**DOX n(%)**	**OFX n(%)**	**SXT n(%)**	**AMX n(%)**
K Pneumoniae (27)	S	-	11(40.74)	24(88.9)	21(77.78)	21(77.78)	18(66.67)	18(66.67)	17(62.96)	19 (70.37)	20 (74.07)	10(37.04)	12(44.44)
	I	-	8 (29.63)	1(3.70)	1(3.70)	0(0)	1(3.70)	2(7.41)	22(7.41)	3(11.11)	1(3.70)	5	1(3.70)
	R	-	8 (29.63)	2(7.41)	5(18.52)	6 (22.22)	8 (29.63)	7(25.58)	8 (29.63)	5(18.52)	6 (22.22)	12(44.44)	14(51.48)
S aureus (16)	S	13(81.3)	14(87.50)	15(93.5)	12(75)	16(100)	10(62.25)	15(93.75)	13(81.25)	11(68.75)	13(81.25)	8(50.0)	4(25.00)
	I	0(0)	1(6.25)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	2(12.50)	2(12.50)	0(0)	5(31.25)
	R	3(18.75)	1(6.25)	1(6.25)	4(25)	0(0)	6(37.75)	1(6.25)	3(18.75)	3(18.75)	1(6.25)	8(50.0)	7(43.75)
E coli (22)	S	-	16(72.73)	19(86.7)	15(68.18)	20(90.91)	15(68.18)	18(81.2)	18(81.82)	13(59.09)	17(77.27)	10(45.46)	6(27.27)
	I	-	1(4.55)	1(4.55)	3(13.64)	0(0)	2(9.09)	2(9.09)	2(9.09)	5(22.73)	2(9.09)	1(4.55)	5(22.73)
	R	-	5(22.73)	2(9.09)	4(18.18)	2(9.09)	5(22.73)	2(9.09)	2(9.09)	4(18.18)	3(13.64)	1(4.55)	11(50.00)
Proteus mirabilis (6)	S	-	1(16.67)	5(83.33	1(16.67)	5(83.33)	3(50.00)	1(16.67)	3(50.00)	5(83.33)	4(66.67)	1(16.67)	2(33.33)
	I	-	2(33.33)	1(16.6)	0(0)	0(0)	1(16.67)	3(50.00)	2(33.33)	1(16.67)	0(0)	3(50.00)	0(0)
	R	-	3(50.00)	0(0)	5(83.33)	1(16.67)	2(33.33)	2(33.33)	1(16.67)	0(0)	2(33.33)	2(33.33)	4(66.67)
CONS (8)	S	6(75.00)	7(87.50)	6(75.0)	4(50.00)	7(87.50)	4(50.00)	7(87.50)	8(100.00)	7(87.50)	7(87.50)	3(37.50)	2(25.00)
	I	1(12.50)	0(0)	0(0)	2(25.00)	0(0)	0(0)	0(0)	0(0)	0(0)	1(12.50)	1(12.50)	1(12.50)
	R	1(12.50)	1(12.50)	2(25.0)	2(25.00)	1(12.50)	4(50.00)	1(12.50)	0(0)	1(12.50)	0(0)	4(50.00)	5(62.5)
Pseudomonas (3)	S	-	3(100.00)	3(100.0)	2(66.67)	3(100.00)	2(66.67)	3(100.0)	2(66.67)	2(66.67)	2(66.67)	1(33.33)	0(0)
	I	-	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	1(33.33)	0(0)	2(66.67)
	R	-	0(0)	0(0)	1(33.33)	0(0)	1(33.33)	0(0)	1(33.33)	1(33.33)	0(0)	2(66.67)	1(33.33)
TOTAL (82)	S	19(79.17)	52(63.41)	70(85.7)	59(71.95)	72(87.8)	52(63.41)	62(75.61)	61(74.39)	57(69.51)	63 (76.83)	33(40.24)	26(31.71)
	I	1 (4.16)	12(14.63)	3(3.66)	7(8.54)	0(0.00)	4 (4.88)	7(8.54)	6 (7.32)	11 (13.41)	7 (8.54)	10(12.20)	14 (17.07)
	R	4(16.67)	18(21.95)	9(10.98)	16(19.51)	10(12.20)	26 (31.71)	13(15.85)	15(18.29)	14 (17.07)	12 (14.63)	39(47.56)	42(51.22)

Table 4: The Antibiotic Sensitivity Pattern of UTI's Isolates.

Key: VA: Vancomycin, TET: Tetracycline (30 μg), IMP: Imipenem, CN; Gentamicin (20 μg), CTX: Cefotaxime (30μg), ERY: Erythromycin, CRO: Ceftriaxone (30 μg), CIP: Ciprofloxacin (5 μg), DOX: Doxycycline, OFX: Ofloxacin, SXT: trimethoprim-sulfamethoxazole (25 μg), AMX: Amoxicillin, S: Sensitive, I: Intermediate, R: Resistant.

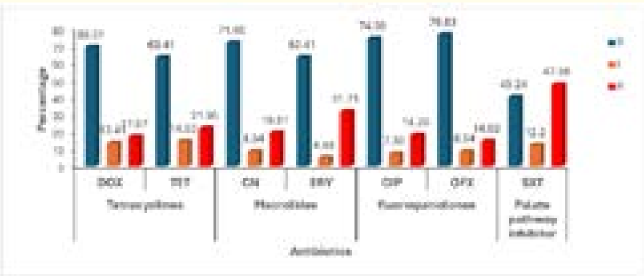

Figure 4: Antibiotic susceptibility pattern Tetracyclines, Macrolides, fluoroquinolones and SXT to UTI isolates.

The Multidrug-resistant Patterns of bacteria isolated from reproductive-age females

All the isolates showed multidrug resistance (100%), and *K pneumoniae (*30.49%)*, Staphylococcus aureus* (19.51%) *and E coli* (31.71%) were the most multidrug-resistant species. The most frequent patterns of MDR were AMX-ERY-STX (24.39%), AMX-CN-STX (19.51%), and CN-CRO-TET (12.02%) (Table 5).

Antibiotic agent	n (%)	*K Pneumoniae*	*S aureus*	*E coli*	*Proteus mirabilis*	*CONS*	Pseudomonas
AMX- CN-STX	16 (19.51)	5	3	4	2	2	0
AMX-ERY-STX	20(24.39)	6	4	6	0	3	1
AMX-TET-STX	8(9.76)	3	1	3	0	0	0
AMX-DOX-STX	5(6.01)	1	1	3	0	0	0
AMX-CIP-STX	10(12.02)	3	1	3	1	2	0
AMX- OFX-STX	4(4.88)	2	1	1	0	0	0
AMX-CN-ERY-DOX-TET	6(7.32)	1	1	2	1	1	0
CTX-CRO-IPM-CRO-TET-STX	1(1.23)	1	0	0	0	0	0
CN-CRO-TET	8(9.76)	1	3	3	1	0	0
CRO-CTX-CN-ERY-DOX-TET	5(6.01)	2	1	1	1	0	0
MDR, n (%)	82(100)	25(30.49)	16(19.51)	26(31.71)	6(7.32)	8(9.76)	1(1.23)

Table 5: The Multidrug-resistant Patterns of bacteria isolated from reproductive-age females.

Key: VA: Vancomycin, TET: Tetracycline (30 µg), IMP: Imipenem, CN; Gentamicin (20 µg), CTX: Cefotaxime (30µg), ERY: Erythromycin, CRO: Ceftriaxone (30 µg), CIP: Ciprofloxacin (5 µg), DOX: Doxycycline, OFX: Ofloxacin, SXT: trimethoprim-sulfamethoxazole (25 µg), AMX: Amoxicillin, S: Sensitive, I: Intermediate, R: Resistant.

Discussion

This study assessed the bacterial profile, antibiotic susceptibility pattern and associated factors of UTI among reproductive-age females attending the Logbaba District Hospital. From our findings, the overall prevalence of UTIs in reproductive-age females in this study was 33.33%. Out of this bacterial UTI prevalence, symptomatic and asymptomatic patients reported a prevalence of 50/121 (41.32%) and 32/138 (23.19%), respectively. This is comparable to the prevalence of 31% of UTIs reported in Buea, Cameroon [4], and 32.2% reported in Bushenyi District, Uganda [13]. Our result is higher than the 20.4% reported in India [28], Southern Ethiopia 7.8% [14], and in Zambia 16.5% [29]. This difference in results could be due to variations in the environment, social habits of the community, and the standard of personal hygiene, sexual behaviour, limited healthcare infrastructure, diagnostic tools, the populations studied differ and education or may be due to the low economic status of the study subjects. The differences in design and methodologies might also affect the comparison of prevalence in different surveys.

In this study, associated factors were also determined; the history of previous UTI and symptoms of UTI were independent risk factors for the acquisition of UTI. Recurrent urinary tract infections may be linked to ascending of urethral microbiota to the bladder and/or untreated chronic/persistent bladder infection resulting from either ascending or bloodstream infections [17]. Also, it may be caused by the persistence of resistant strains from previous uropathogenic infections or by the recurrence of those illnesses. Ages between 21-30 and 31-40 years were predictors of UTIs. Our result aligns with Ngong., *et al*. [4], who reported a significant association between UTI and advanced age. This is probably because within these age groups, women are more often pregnant for the first or second time or involved in sexual activities, and thus more likely to have been exposed to obstetric conditions, that predispose them to UTIs. Participants who were using water cistern toilets had a nearly four-fold higher risk of UTIs as compared to participants using other toilet systems. This is probably because water cistern toilet supports the growth of bacteria and predispose individuals that use such toilets. Reproductive-age females with urinary frequency were five times more likely to have a positive culture. These findings concurred with a study in Ethiopia by Mekonnen., *et al.* [30], which reported urine frequency as a predictor of UTI. Infections, injuries, diabetes or irritation of the bladder, as well as changes in the muscles and nerves that regulate bladder function, could all be associated with urine frequency. Significant bacteriuria was associated with secondary educational level. This might be due to the insufficient knowledge of reproductive-age females about the transmission and prevention of uropathogens.

In this study, Gram-negative bacterial isolates were more prevalent than Gram-positive bacterial isolates (70.7% vs 29.3%). Our finding is consistent with Fenta., *et al*. [17], who reported that gram-negative was the predominant bacteria in their finding. The possible explanation for the predominance of Gram-negative bacteria among isolated UTI aetiological agents may be because they are common members of the vaginal and rectal fora. *Klebsiella pneumoniae* was the most frequent species 27 (32.9%), followed by *E coli* 22(26.8%), *Staphylococcus aureus* 16 (19.5%), CONS 8 (9.8%), *Proteus mirabilis* 6 (7.3%) and *Pseudomonas aeruginosa* 3(3.7%). This finding is similar to a study carried out in Abakaliki, Nigeria, where *Klebsiella spp*. (24.5%) was the most dominant isolate Muoneke., *et al*. [31] and contradict Ngong., *et al*. [4], and some studies in Ethiopia where *E. coli* was the most predominant isolate [17,32]. This disparity may be due to variations in specimen collection techniques and the presence of multiple virulence factors. *K. pneumoniae* predominance may be due to catheter biofilm formation or increasing resistance of the bacteria to antibiotics [33]. Also, it is commonly found in wet areas, especially in health institutions and could be associated with hospital-acquired infections [34]. Another reason could be poor genital hygiene practices by reproductive-age females who may find it difficult to clean properly after defecating or clean their genitalia after passing urine during their pregnancy [9,17]. Additionally, adhesion structures, such as adhesins, may facilitate the progression of *Klebsiella pneumoniae* to the bladder. Furthermore, the capsule polysaccharide (CPS) of *K. pneumoniae* promotes resistance to phagocytosis and serum bactericidal activity [35].

Antibiotic susceptibility tests show that most isolates were susceptible to cefotaxime (87.80%), followed by Imipenem (85.7%), Vancomycin (79.27%) (to gram-positive bacteria only), Ofloxacin (76.83%), Ceftriaxone (75.61%), Ciprofloxacin (74.39%), Gentamicin (71.95%) and Doxycycline (69.51%). Our results might be because cefotaxime and Imipenem are not widely available in the community, which minimised the chance of abuse. Our findings partly agreed with Ngong., *et al*. [4], where Ciprofloxacin and Gentamicin (75.6%) were the most sensitive antibiotics and also partly in line with Fenta., *et al*. [17], which reported that Gentamicin and Meropenem were the most sensitive antibiotics. High resistance to Amoxicillin, trimethoprim-sulfamethoxazole, erythromycin and Tetracycline was detected. The irrational use and abuse of broad-spectrum antibiotics due to their affordability and easy access may be the reason for the high resistance to these drugs. Nine (9) (10.98%) isolates were resistant to imipenem, which may be a threat to the antibiotic options available for the treatment of infections because carbapenems have the highest potency against bacteria. It is for this reason that they are reserved and used for more severe infections or as last-line drugs.

From our findings all isolates (100%) exhibited multidrug resistance (MDR) with *Klebsiella pneumoniae* (30.49%), *Staphylococcus aureus* (19.51%), and *Escherichia coli* (31.71%) as the predominant MDR species, in line with global trends showing a high burden of MDR bacteria, especially in gram-negative species like *K. pneumoniae* and *E. coli,* which are frequently implicated in healthcare-associated infections [36]. However, the 100% MDR rate here is notably higher than the average MDR prevalence reported in West Africa (around 59%) and globally, where MDR rates vary but rarely reach full saturation across all isolates [36]. The high MDR rates threaten the effective treatment of UTIs among reproductive-age females, as there are greater incidences of antibiotic resistance to popular antimicrobial drugs used to treat urinary tract infections. Additionally, this may result in a lengthier treatment period and hospitalization, which can take a toll on family or caregivers [32]. Untreated UTIs in reproductive-age females can lead to pelvic inflammatory disease, thus leading to infertility. The rise of multidrug-resistant (MDR) pathogens may be driven by factors such as antibiotic misuse, overprescription, and inadequate infection control practices in healthcare settings. Inappropriate use, including not completing prescribed courses or using antibiotics for viral infections, accelerates resistance, and limited antimicrobial stewardship programs [18]. Poor infection prevention and control measures in hospitals further contribute to MDR. To combat this, policymakers should prioritize strengthening antibiotic stewardship programs, ensuring antibiotics are prescribed only when necessary, and focusing on education for both healthcare professionals and the public. Enhanced surveillance systems can also help track resistance patterns, while improving sanitation and hygiene in healthcare facilities is crucial. International cooperation is needed to address the global scope of MDR [18].

Moreover, the dominant MDR patterns involving amoxicillin (AMX), erythromycin (ERY), and trimethoprim-sulfamethoxazole (STX), as well as combinations with gentamicin (CN) and ciprofloxacin (CIP), reflect common antibiotic classes widely used in both community and hospital settings [36]. These patterns likely result from selective pressure due to frequent empirical use of these antibiotics, facilitating the emergence of resistance genes conferring cross-resistance. Similar resistance profiles have been documented in other studies where β-lactams, macrolides, and sulfonamides are among the most compromised drugs, often due to plasmid-mediated resistance and horizontal gene transfer [36]. The presence of these specific MDR patterns shows that the is a urgent need for targeted antibiotic stewardship, enhanced surveillance, and tailored treatment guidelines to reduce the spread of resistant strains in the region.

Klebsiella pneumoniae, E. coli, and Staphylococcus aureus were the most MDR strains. The acquisition of resistance may occur either through mutations (which change the target site of bacteria within their genetic material) or through the acquisition of new genetic material from other bacteria [37]. Additionally, the alarming increase in resistance may stem from various antibiotic resistance mechanisms, including the prevention of antibiotic uptake (by turning off the production of porin channel proteins), the modification of drug targets, the inactivation of drugs through enzyme production, and the enhancement of drug efflux pumps [37].

Conclusions

In this study, the prevalence of UTIs among reproductive-age females was 82/259 (31.66%). *Klebsiella pneumoniae* and *Escherichia coli* were the most predominant isolates. According to this study, ages between 21-30 years and 31-40 years, students, history of UTI, presence of symptoms and secondary education were predictors of UTI. The majority of the isolates were sensitive to Cefotaxime, Imipenem and Vancomycin, and most of the bacterial isolates were resistant to Amoxicillin and trimethoprim-sulfamethoxazole. All the isolates were multidrug-resistant (100%), and *Klebsiella pneumoniae* and *E coli* were the most resistant species. Therefore, there is a need to perform urine culture and antibiotic susceptibility before treatment of UTIs, since this will limit the progress of drug resistance.

Strengths

- **Robust Methodology:** Standardized urine culture and antibiotic susceptibility testing methods ensured accurate data, with multivariate regression adding statistical strength.

Weaknesses

- **Convenience Sampling Bias:** The use of convenient sampling may limit the generalizability of the findings due to selection bias and the sample size.
- **Cross-Sectional Design:** The study's cross-sectional nature only provides a snapshot, limiting the ability to establish causal relationships between risk factors and UTIs.

Benefit of the study

- **Targeted Antimicrobial Therapy:** The study's findings on antibiotic susceptibility and multidrug resistance can guide healthcare providers in selecting more effective treatments, helping to improve patient outcomes and reduce the spread of resistant strains.

- **Informed Public Health Strategies:** By identifying risk factors and the prevalence of UTIs in reproductive-age females, the study can inform targeted interventions, education, and prevention programs to reduce UTI incidence and associated complications in the community.

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Authors' Contributions

Conceptualization: NFA, SKA and TPB; Data curation: NFA, TPB and EDN; Formal analysis: NFA and ECA; Investigation: NFA, BVT and ECA; Methodology: SBN, NFA, NNJ and EDN; Project supervision: EDN and NFA; Validation: NFA, SKA; Visualization: NFA, TPB and NNJ; Writing of original draft: NFA, ECA, SBN, BVT and EDN.

Consent for Publication

Not applicable.

Competing Interests

The authors declare that they have no competing interests.

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