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Antibiotic Resistance Profiling of Uropathogens Isolated from Urinary Tract Infections in Females at a Tertiary Care Hospital in Peshawar

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ABSTRACT

Background: Urinary tract infections (UTIs) are among the most frequent bacterial infections affecting women and represent a major cause of outpatient visits and hospital admissions. The increasing emergence of multidrug-resistant uropathogens has complicated empirical treatment, particularly in developing countries where antibiotic misuse is common. **Objective:** To determine the distribution of uropathogens and assess antimicrobial resistance patterns among women presenting with urinary tract infection at a tertiary care hospital in Peshawar. **Methodology:** A cross-sectional observational study was conducted at the Department of Pathology, Khyber Teaching Hospital, Peshawar, from 27th May 2025 to 27th Oct 2025. Midstream urine samples from 300 symptomatic female patients aged 20–80 years were cultured. Isolates were identified using standard microbiological techniques, and antimicrobial susceptibility testing was performed using the Kirby–Bauer disc diffusion method in accordance with CLSI 2025 guidelines. **Results:** Out of 300 urine samples, 85 (28.3%) yielded significant bacterial growth. *Escherichia coli* was the most frequently isolated organism (64.7%), followed by Citrobacter species (7.0%) and Enterobacter species (5.8%). Overall, high resistance was observed against ampicillin (82.4%), ciprofloxacin (58.8%), and co-trimoxazole (52.9%). Among *E. coli* isolates, ampicillin resistance was particularly high (90.9%). Nitrofurantoin and fosfomycin demonstrated comparatively low resistance rates. Multidrug resistance was predominantly observed among *E. coli* isolates. **Conclusion:** A high prevalence of multidrug-resistant *E. coli* limits the effectiveness of commonly used antibiotics in this region. Nitrofurantoin and fosfomycin remain reliable options for empirical therapy in uncomplicated UTIs.

INTRODUCTION

Urinary tract infections are among the most common bacterial infections encountered in clinical practice and disproportionately affect women due to anatomical and physiological factors. Globally, millions of women experience at least one episode of UTI during their lifetime, resulting in substantial healthcare utilization and economic burden. In Pakistan, UTIs remain a frequent cause of outpatient consultations, yet local data on antimicrobial resistance patterns remain limited (1-3).

Escherichia coli is the most prevalent uropathogen worldwide and possesses multiple virulence factors that enhance its ability to adhere to uroepithelial cells, evade host immune responses, and persist within the urinary tract. Other Gram-negative organisms such as Klebsiella, Proteus, Enterobacter, and Citrobacter species also contribute to infection burden, particularly in complicated cases and hospitalized patients (4-6).

The management of UTIs has become increasingly challenging due to the rising prevalence of multidrug-resistant organisms. The widespread availability of antibiotics without prescription, incomplete treatment courses, and inappropriate empirical prescribing practices have accelerated the emergence of resistance. This has resulted in reduced effectiveness of commonly used antibiotics, including beta-lactams and fluoroquinolones, limiting oral treatment options (7-10).

Local surveillance studies are essential to guide empirical therapy and formulate region-specific antibiotic guidelines. However, updated resistance data from Khyber Pakhtunkhwa remain scarce. Therefore, the present study was undertaken to determine the bacterial profile of urinary tract infections in women attending a tertiary care hospital in Peshawar and to evaluate current antimicrobial resistance patterns in order to support evidence-based treatment strategies.

METHODOLOGY

Study Design and Setting

This observational cross-sectional study was conducted in the Department of Pathology, Khyber Teaching Hospital (KTH), Peshawar, a major tertiary care referral center serving patients from Peshawar and surrounding districts of Khyber Pakhtunkhwa. The study was carried out over a six-month period from 27th May 2025 to 27th Oct 2025. Ethical approval for this study was obtained from the Institutional Research and Ethical Review Board (IREB), Khyber Medical College / Khyber Teaching Hospital, Peshawar. The study was approved under reference number No. 544/DME/KMC, dated 27th May 2025. All procedures were conducted in accordance with institutional ethical standards. Written informed consent was obtained from all participants prior to sample collection, and confidentiality of patient information was strictly maintained throughout the study period.

Study Population

The study included symptomatic female patients aged 20–80 years who presented to outpatient departments and inpatient wards with clinical features suggestive of urinary tract infection. Symptoms considered for enrollment included dysuria, urinary frequency, urgency, suprapubic discomfort, and flank pain. Patients who had received systemic antibiotics within the preceding 72 hours, those with known chronic renal disease, indwelling urinary catheters, or pregnancy were excluded to minimize confounding effects on culture yield and resistance patterns.

Sample Size and Sampling Technique

A total of 300 urine samples were collected using a non-probability consecutive sampling technique from eligible patients who met the inclusion criteria during the study period.

Sample Collection and Processing

Participants were instructed regarding proper midstream clean-catch urine collection. Approximately 10–15 mL of urine was collected in sterile, wide-mouth containers. Samples were transported to the microbiology laboratory within one hour of collection. In cases where immediate processing was not possible, samples were refrigerated at 4°C and processed within 24 hours.

Culture and Identification of Isolates

Urine specimens were inoculated onto cystine lactose electrolyte deficient (CLED) agar and blood agar using a calibrated 0.001 mL loop and incubated aerobically at 37°C for 18–24 hours. Significant bacteriuria was defined as a growth of $\geq 10^5$ colony-forming units (CFU)/mL.
Bacterial isolates were initially identified based on colony morphology, Gram staining, and standard biochemical tests. Final confirmation of Gram-negative organisms was performed using the Analytical Profile Index (API) identification system (API 20E, bioMérieux, Marcy l'Étoile, France) according to the manufacturer's instructions.

Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing was performed by the Kirby Bauer disc diffusion method on Muelle –Hinton agar. The interpretation of zone diameters was carried out in accordance with Clinical and Laboratory Standards Institute (CLSI) 2025 guidelines. The antibiotics tested included ampicillin, amoxicillin, co-amoxiclav, ceftriaxone, cefotaxime, cefpirome, ciprofloxacin, levofloxacin, co-trimoxazole, nitrofurantoin, fosfomycin, amikacin, meropenem, and imipenem. *Escherichia coli* ATCC 25922 was used as the quality control strain.

Definition of Multidrug Resistance

Multidrug resistance was defined as resistance to three or more classes of antimicrobial agents.

Data Analysis

Data were entered and analyzed using Statistical Package for Social Sciences (SPSS) version 26. Categorical variables were summarized as frequencies and percentages. Results were presented in tables and graphical formats.

RESULTS

A total of 300 mid-stream urine samples were collected from symptomatic female patients. Among these, 85 samples yielded significant bacterial growth, giving an overall culture positivity rate of 28.3%.

Table 1

Frequency of Culture-Positive Urinary Tract Infections (n=300)

Culture Result	Frequency	Percentage (%)
Positive	85	28.3
Negative	215	71.7
Total	300	100

Table 2

Distribution of Uropathogens Isolated from Positive Cultures (n = 85)

Organism	Frequency	Percentage (%)
Escherichia coli	55	64.7
Citrobacter species	6	7.0
Enterobacter species	5	5.8
Klebsiella species	5	5.8
Enterococcus species	4	4.7
Morganella morganii	3	3.5
Proteus species	3	3.5
Staphylococcus aureus	3	3.5
Providencia species	2	2.3
Total	85	100

E. coli was the dominant isolate, accounting for nearly two-thirds of all infections.

Table 3

Overall Antimicrobial Resistance Pattern Among All Uropathogens (n = 85)

Antibiotic	Resistant (n)	Percentage (%)
Ampicillin	70	82.4
Ciprofloxacin	50	58.8
Co-trimoxazole	45	52.9
Ceftriaxone	42	49.4
Cefotaxime	40	47.1
Levofloxacin	35	41.2
Co-amoxiclav	32	37.6
Nitrofurantoin	11	12.9
Fosfomycin	10	11.8
Amoxicillin	1	1.2
Cefpirome	1	1.2
Imipenem	1	1.2

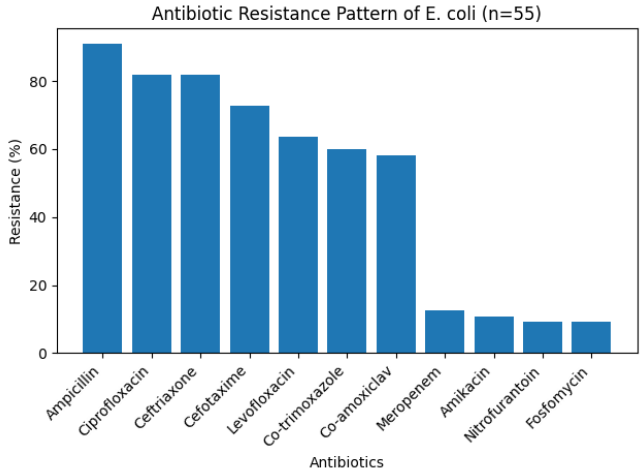
Ampicillin demonstrated the highest resistance rate, while carbapenems and urinary-specific agents showed the lowest resistance.

Table 4
Antibiotic Resistance Profile of Escherichia Coli Isolates (n=55)

Antibiotic	Resistant (n)	Percentage (%)
Ampicillin	50	90.9
Ciprofloxacin	45	81.8
Ceftriaxone	45	81.8
Cefotaxime	40	72.7
Levofloxacin	35	63.6
Co-trimoxazole	33	60.0
Co-amoxiclav	32	58.2
Meropenem	7	12.7
Amikacin	6	10.9
Nitrofurantoin	5	9.1
Fosfomycin	5	9.1

Multidrug resistance (resistance to ≥3 antimicrobial classes) was predominantly observed in *Escherichia coli* isolates. Most MDR strains exhibited combined resistance to beta-lactams, fluoroquinolones, and folate pathway inhibitors, significantly limiting first-line oral treatment options.

Figure 1
Antibiotic Resistance Pattern of Escherichia coli Isolates (n=55).



High resistance was observed against ampicillin, ciprofloxacin, and third-generation cephalosporins, whereas nitrofurantoin, fosfomycin, amikacin, and meropenem retained good activity against *E. coli* isolates.

DISCUSSION

Urinary tract infections remain a major cause of morbidity among women, particularly in developing countries where empirical antibiotic use is common. The present study provides contemporary data on the bacteriological profile and antimicrobial resistance patterns of uropathogens isolated from female patients attending a tertiary care hospital in Peshawar. The overall culture positivity rate of 28.3% observed in this study is comparable to rates reported from other regional centers in Pakistan, indicating a consistent burden of laboratory-confirmed UTIs among symptomatic women (11-13).

Escherichia coli emerged as the predominant pathogen, accounting for 64.7% of isolates. This finding aligns with international and regional literature that consistently identifies *E. coli* as the principal uropathogen due to its virulence factors such as adhesins, fimbriae, and biofilm-forming capacity, which facilitate colonization of the urinary tract. The presence of other Gram-negative organisms, including Citrobacter, Enterobacter, Klebsiella, and Proteus species, reflects the polymicrobial nature of UTIs and highlights the importance of comprehensive culture-based diagnosis (14-16).

A notable finding of this study is the high resistance rate to commonly prescribed oral antibiotics, particularly ampicillin, ciprofloxacin, and co-trimoxazole. Overall ampicillin resistance exceeded 80%, while resistance among *E. coli* isolates was even higher (90.9%), rendering this agent clinically ineffective for empirical therapy in this population. Similarly, fluoroquinolone resistance was markedly high, which is concerning given their widespread use as first-line agents for UTIs. These resistance trends are likely driven by inappropriate antibiotic prescribing, self-medication, and easy over-the-counter availability of antimicrobials in the region (17-19). The resistance pattern observed among *E. coli* isolates further underscores the growing threat of multidrug resistance. Most isolates demonstrated resistance to multiple antibiotic classes, significantly narrowing effective treatment options. In contrast, nitrofurantoin and fosfomycin retained good activity against *E. coli*, while carbapenems showed the highest efficacy, though their use should be reserved for severe or complicated infections to prevent further resistance development (20). These findings emphasize the urgent need for regular antimicrobial surveillance, strict antibiotic stewardship policies, and rational prescribing practices in healthcare facilities across the region.

CONCLUSION

Escherichia coli remains the leading cause of urinary tract infections among women in Peshawar, with a high prevalence of multidrug-resistant strains. Widespread resistance to commonly used antibiotics such as ampicillin, ciprofloxacin, and co-trimoxazole limits their effectiveness for empirical treatment. Nitrofurantoin and fosfomycin demonstrated favorable susceptibility profiles and should be considered as first-line agents for uncomplicated UTIs in this region. Continuous surveillance of antimicrobial resistance patterns and the implementation of antibiotic stewardship programs are essential to curb the rising threat of resistant uropathogens and to optimize patient outcomes.

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