

Original Article

ANTIMICROBIAL RESISTANCE PATTERNS OF UROPATHOGENS CAUSING URINARY TRACT INFECTIONS AMONG THE ADULTS IN A TERTIARY CARE CENTRE-A DESCRIPTIVE STUDY

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ABSTRACT

Objective: Urinary tract infections (UTIs) are among the most common bacterial infections worldwide, particularly affecting women. Rising antimicrobial resistance has made management increasingly challenging, especially in resource-limited settings. This study aimed to identify the predominant uropathogens causing UTIs in adults and evaluate their antimicrobial resistance patterns in a tertiary care hospital in Tirupati, Andhra Pradesh.

Methods: A descriptive study was conducted over three months (January–March 2025) in the Department of Microbiology. A total of 180 clean-catch midstream urine samples were collected from adults aged >18 years. Samples were cultured and isolates were identified by microbiological techniques. Antimicrobial susceptibility testing was performed using Kirby–Bauer disc diffusion method according to Clinical and Laboratory Standards Institute (CLSI) guidelines.

Results: Of the 180 patients, 71% were female, showing higher prevalence of UTIs in women. Infections were most frequent among individuals >60 years, followed by those in their 30s. Most samples were from the General Medicine department. *Escherichia coli* was the most common isolate, followed by *Klebsiella pneumoniae*. Both exhibited high resistance to amoxycylav and ciprofloxacin but were more susceptible to imipenem and nitrofurantoin. *Pseudomonas aeruginosa* and *Proteus mirabilis* also showed notable resistance. Among g-positive organisms, *Enterococcus faecalis* largely sensitive to linezolid and vancomycin.

Conclusion: The study highlights significant antimicrobial resistance among UTI pathogens. Routine surveillance and rational antibiotic prescribing based on local susceptibility data are essential to prevent resistance and improve outcomes.

Keywords: Urinary tract infection, Uropathogens, Antimicrobial resistance, Multi-drug resistance, Antibiotic stewardship, Kirby–bauer method

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INTRODUCTION

Urinary Tract Infections (UTIs) refer to infections that affect any part of the urinary system, including the kidneys, ureters, bladder, or urethra [1]. UTIs are one of the most common bacterial infections in humans, accounting for approximately 25% of all bacterial infections [2]. These infections contribute significantly to morbidity and are the second most common reason for hospital visits. Globally, around 150 million people are diagnosed with UTIs every year, leading to economic burdens exceeding 6 billion US dollars annually [3].

The risk of UTIs increases in males over the age of 60 due to prostate enlargement, which obstructs the flow of urine from the bladder [4]. However, the prevalence of UTIs is much higher among females, with about 50% of women experiencing at least one UTI in their lifetime, and 20% to 40% of these women experiencing recurrent infections. In comparison, men account for only about 20% of reported UTI cases [5]. Several factors contribute to the higher incidence of UTIs in adult females, including sexual activity and pregnancy [6].

UTIs are commonly caused by both g-negative and g-positive bacteria, along with certain fungi [7]. In most cases of uncomplicated UTIs, the infections are acquired in the community and are mainly attributed to uropathogenic *Escherichia coli* (UPEC) and *Klebsiella* species, which together are responsible for approximately 75–95% of all UTIs. Less frequently, other pathogens such as *Proteus* species, *Enterobacter* species, *Pseudomonas* species, *Enterococcus faecalis*, *Staphylococcus saprophyticus*, and *Staphylococcus aureus* can also cause UTIs [8].

The rise of antibiotic-resistant bacterial strains is a growing concern in the treatment and management of UTIs, especially in low-income countries, where the prevalence of infections is high, and irrational antibiotic use combined with inadequate infection prevention measures exacerbates the problem [9]. The patterns of antimicrobial resistance in uropathogens can change over time and vary across different geographical regions. Therefore, it is essential to regularly

monitor antimicrobial susceptibility within each region to ensure current and accurate epidemiological data [10]. This study aims to investigate the antimicrobial resistance patterns of various uropathogens isolated from UTI patients, providing vital information for better management and treatment strategies.

MATERIALS AND METHODS

A total of 180 clean catch midstream urine samples from patients above 18 y of age were received from various departments and processed in the Department of Microbiology. The samples inoculated on Cystine Lactose Electrolyte Deficient (CLED) agar, and species-level identification done by biochemical tests according to standard guidelines. Antibiotic susceptibility testing was performed using the Kirby–Bauer disc diffusion method as per CLSI guidelines.

Study design

This Descriptive study was conducted in Dept. of Microbiology of a tertiary care hospital in Tirupati, Andhra Pradesh, from Jan 2025 to March 2025 after obtaining clearance from Institutional Ethics Committee. (Approval letter No.03/2025)

Study population

Received Urine Samples in the Microbiology laboratory, S. V. Medical College, Tirupati.

Inclusion criteria

All urine samples from patients aged 18 y or older, received from various departments with a diagnosis of UTI, were included in the study after confirmation of UTI by microscopic examination in the Department of Microbiology.

Isolation, identification, and characterization of organism

Samples were cultured aerobically on CLED agar, and strains having significant growth (>10⁵cfu/ml) were further processed for identification using standard microbiological techniques [11].

The antibiotic susceptibility test was done by the Kirby-Bauer disc diffusion method by following standard procedures as per CLSI guidelines [12].

Data analysis

All data were maintained in Microsoft Office Excel and appropriate statistical tools were used wherever required.

RESULTS

Gender wise distribution of UTI cases

Table 1 illustrate the gender distribution of UTI cases. Among the 180 cases analyzed, 71.11% (128 cases) were females, while 28.89% (52 cases) were males, indicating a higher prevalence of UTI in females.

Table 1: Gender wise distribution of UTI cases

Gender	Frequency (%)	Total
Male	28.89%	52
Female	71.11%	128

Age-wise distribution of UTI cases

Table 2 presents the frequency distribution of UTI cases across different age groups. The highest prevalence was observed in individuals above 60 y (31.11%, 56 cases), followed by the 31-40 age group (21.66%, 39 cases). The lowest prevalence was noted in the 51-60 age group (11.66%, 21 cases).

Department-wise distribution of UTI cases

Table 3 depict the distribution of UTI cases across major hospital departments. General Medicine reported the highest number of cases (37.8%, 68 cases), followed by General Surgery (32.8%, 59 cases) and obstetrics and gynecology (OBG) (29.4%, 53 cases).

Table 2: Age-wise distribution of UTI cases

Age	Frequency (%)	Total
19-30	32 (17.77%)	36
31-40	39 (21.66%)	37
41-50	32 (17.77%)	32
51-60	21 (11.66%)	21
>60	56(31.11%)	54

Table 3: Total no of samples received from major departments

Department	Frequency	Total
General medicine	37.8%	68
General surgery	32.8%	59
OBG	29.4%	53
Total	100%	180

Table 4: Organisms

Gram negative	Gram positive
E. coli	Enterococcus faecalis
Klebsiella pneumoniae	
Pseudomonas aeruginosa	
Proteus mirabilis	

Gram-negative urinary pathogens resistant (R) to antimicrobial agents

Table 5 shows that *Escherichia coli* was most resistant to both amoxycyclav and ciprofloxacin, with 73.2% of isolates showing resistance. Norfloxacin resistance was also significant at 60.6%, while fewer strains were resistant to nitrofurantoin (16.9%) and imipenem (11.3%). *Klebsiella pneumoniae* had even higher resistance to amoxycyclav (85.7%) and ciprofloxacin (74.6%), with a similarly high resistance to nitrofurantoin (74.6%) and norfloxacin

(60.3%). Resistance to imipenem (34.9%) and piperacillin-tazobactam (49.2%) was moderate. *Proteus mirabilis* showed 83.3% resistance to nitrofurantoin and 66.7% to amoxycyclav, while resistance to norfloxacin and ciprofloxacin was at 50% each. It had relatively lower resistance to piperacillin-tazobactam (33.3%) and imipenem (16.7%). Meanwhile, *Pseudomonas aeruginosa* exhibited 92% resistance to amoxycyclav and 76% to norfloxacin, with 80% resistance to ciprofloxacin and 72% to nitrofurantoin. Resistance to imipenem (48%) and piperacillin-tazobactam (60%) was comparatively lower but still notable.

Table 5: Overall number (%) of g-negative urinary pathogens resistant (R) to antimicrobial agents

Antibiotics	E. coli (71)	Klebsiella pneumoniae (63)	Proteus mirabilis (6)	Pseudomonas aeruginosa (25)
Amoxycyclav	52 (73.2%)	54 (85.7%)	4 (66.7%)	23(92%)
Ciprofloxacin	52 (73.2%)	47 (74.6%)	3 (50.0%)	20 (80.0%)
Imipenem	8 (11.3%)	22 (34.9%)	1 (16.7%)	12 (48.0%)
Nitrofurantoin	12 (16.9%)	47 (74.6%)	5 (83.3%)	18 (72.0%)
Piperacillin-Tazobactam	20 (28.2%)	31 (49.2%)	2 (33.3%)	15 (60.0%)
Norfloxacin	43 (60.6%)	38 (60.3%)	3 (50.0%)	19 (76%)

Gram-positive urinary pathogens resistant(R) to antimicrobial agents

Table 6 shows *Enterococcus faecalis* was most resistant to ciprofloxacin, with 46.7% of the samples not responding to it. The next highest resistance was to norfloxacin at 40%. About 27% of the samples were also resistant to tetracycline. Only a small number of samples (6.7%) were resistant to vancomycin and nitrofurantoin. All the samples were sensitive to linezolid.

Table 6: Overall number (%) of g-positive urinary pathogens resistant(R) to antimicrobial agents

Antibiotics	Enterococcus faecalis (15)
Vancomycin	1 (6.7%)
Ciprofloxacin	7 (46.7%)
Linezolid	0 (0%)
Nitrofurantoin	1 (6.7%)
Tetracycline	4 (26.7%)
Norfloxacin	6 (40.0%)

DISCUSSION

Urinary tract infections (UTIs) are a common health problem seen in many people, both in hospitals and in daily life. They are caused by different germs, and the best medicine to treat them can change over time. That's why it's important to regularly check which antibiotics are working in a local area. This helps doctors choose the right treatment and take better care of patients.

Our finding that about 71% of UTI cases were in females lines up closely with what many other studies have reported. For example, Magliano *et al.* found that nearly 80% of UTI cases occurred in women [13], and Lo *et al.* observed a similar figure around 73% [14]. Harrington *et al.* noted that young, sexually active women are especially at risk, which helps explain why the numbers are so high [15]. Deltourbe *et al.* also emphasized that UTIs are generally much more common in women than men [16]. Even research focused on specific treatments, like the study by Bhat *et al.*, showed that women made up 80% of UTI cases [17]. Altogether, these studies strongly support our observation that women are far more affected by UTIs than men, a trend seen consistently across different populations and healthcare settings.

Women are more likely to get UTIs than men, and there are some clear reasons behind it. Bono MJ *et al.* pointed out that women have a shorter urethra, which means bacteria don't have to travel far to reach the bladder [18]. Hooton *et al.* added that the urethra is also closer to the anus, making it easier for bacteria to enter [19]. Scholes *et al.* found that being sexually active can raise the risk too, since it can push bacteria into the urinary tract [20]. And as Raz *et al.* explained, after menopause, falling estrogen levels can make the urinary tract more fragile and less protected [21]. Put all these factors together, and it's easy to see why UTIs are more common in women.

In our study, we found that urinary tract infections (UTIs) were most common in people over 60 y old (31.11%), followed by those in the 31–40 age group (21.66%). Interestingly, the 51–60 age group had the lowest number of cases (11.66%). This trend is quite similar to what Janifer *et al.* observed—they also saw that older adults are more likely to be affected by UTIs [22]. However, Prakash D *et al.* found a different pattern, with more cases in women aged 26–36 and men aged 48 and above [23]. Sowjanya *et al.* also had different results, reporting the highest number of cases among women of reproductive age [24]. These differences might be explained by things like hormonal shifts, levels of sexual activity, or even the specific patient groups each study focused on.

In our study, we found that most urinary tract infection (UTI) cases were reported from the General Medicine department (37.8%), followed by General Surgery (32.8%) and Obstetrics and Gynecology (29.4%). This pattern closely matches the findings of Chandrasekhar D *et al.*, who also observed more UTI cases in General Medicine—likely because patients in this department often have multiple

underlying conditions that raise their risk [25]. Similarly, Kamat US *et al.* reported a higher number of UTI cases in both Medicine and Surgery departments, which could be due to factors like prolonged catheter use, surgical interventions, and frequent exposure to antibiotics that are common in these hospital settings [26].

Escherichia coli showed high resistance to amoxyclav and ciprofloxacin (73.2%), and *Klebsiella pneumoniae* displayed even higher resistance to amoxyclav (85.7%) and ciprofloxacin (74.6%), while nitrofurantoin and imipenem retained better efficacy. These findings are in line with Mortazavi-Tabatabaei SAR *et al.*, who also reported high resistance in *E. coli* to amoxicillin/clavulanic acid and ciprofloxacin, but lower resistance to nitrofurantoin and imipenem [27]. In contrast, Caskurlu H *et al.* documented a lower resistance rate to ciprofloxacin (rising up to 43%) among *E. coli* strains, which is considerably below our finding of 73.2% [28]. Also, Yilmaz Net *et al.* found resistance to nitrofurantoin in *E. coli* to be less than 1%, markedly different from our 16.9% [29]. Additionally, Abdullah FE *et al.*, reported lower resistance rates for *Klebsiella pneumoniae* to ciprofloxacin, in contrast to the elevated levels seen in our study [30]. *Pseudomonas aeruginosa* showed high resistance to several commonly used antibiotics—amoxyclav (92%), ciprofloxacin (80%), norfloxacin (76%), and nitrofurantoin (72%). Resistance to imipenem (48%) and piperacillin-tazobactam (60%) was comparatively moderate. These results are in line with findings from Khan MA *et al.*, who also reported high resistance to ciprofloxacin, nitrofurantoin, and β -lactam antibiotics in *Pseudomonas* strains isolated from UTI patients [31]. On the other hand, Marepalli *et al.* found much lower resistance rates to ciprofloxacin (20%) and nitrofurantoin (15%), suggesting that regional differences in antibiotic usage and microbial exposure might influence resistance patterns [32]. Similarly, Abdullah FE and colleagues observed lower resistance to piperacillin-tazobactam and imipenem, which could be attributed to stricter infection control practices or differing hospital policies during their study period [30]. *Enterococcus faecalis* exhibited the highest resistance to ciprofloxacin (46.7%), followed by norfloxacin (40%) and tetracycline (26.7%). Linezolid resistance was observed in 13.3% of isolates, while vancomycin and nitrofurantoin were the most effective, with only 6.7% resistance each. These findings are in line with those of Lee G *et al.*, who also observed a 47% resistance rate to ciprofloxacin and 58% to norfloxacin, closely mirroring our results [33]. Similarly, Balaei Gajan E *et al.* reported that *E. faecalis* isolates showing 44% resistance to ciprofloxacin, 44% to doxycycline (a tetracycline group antibiotic), and low resistance to linezolid (5.1%), vancomycin (3.6%), and nitrofurantoin (18.6%) in hospitalized patients with UTIs [34]. On the other hand, a study by Goel V *et al.* from North India reported much higher resistance rates—74.8% to ciprofloxacin and 66.1% to norfloxacin—suggesting that regional differences in antibiotic usage and local microbial patterns may significantly influence resistance trends [35].

Antibiotic resistance in urinary tract infections (UTIs) happens for several reasons. Gupta *et al.* pointed out that when antibiotics, especially broad-spectrum ones, are overused or misused, it creates the perfect conditions for resistant bacteria to thrive [36]. Ventola *et al.* added that not finishing a full course of antibiotics can leave behind some bacteria, which then adapt and become harder to kill next time. In some places, people can get antibiotics without a prescription, which often leads to self-medication and improper use [37]. On top of that, Donlan and Costerton explained that some bacteria, like *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*, form biofilms, a kind of protective shield that help them survive even in the presence of antibiotics [38]. All these factors together explain why we're seeing such strong resistance patterns in our study.

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AUTHORS CONTRIBUTIONS

All authors have contributed equally

CONFLICT OF INTERESTS

Declared none

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