

Antibiotic Resistance in First-Time Simple Utis Among Adult Patients in Duhok, Kurdistan Region of Iraq

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ABSTRACT

Background: Urinary tract infections (UTIs) are among the most bacterial infections, and increasing antimicrobial resistance has reduced the reliability of empirical treatment. This study evaluated the bacterial etiology and antimicrobial susceptibility patterns of first-time uncomplicated UTIs among adult patients in Duhok, Kurdistan Region of Iraq.

Methods: A cross-sectional study was conducted among 116 adults with first-time uncomplicated UTIs were at five outpatient health care sites from March 2025 to March 2026. Urine cultures and antimicrobial susceptibility testing were performed for each participant using the VITEK® automated system.

Results: Out of 116 participants, 89 (76.7%) had positive urine cultures. *Escherichia coli* was the predominant uropathogen, accounting for 69% of isolates. High rates of resistance were observed for amoxicillin (75.3%), cefotaxime (71.9%), and azithromycin (67.4%). In contrast, resistance was low to nitrofurantoin (11.2%), amikacin (6.7%) and imipenem (1.1%). Overall, 59.6% of isolates were classified as multidrug resistant.

Conclusion: *E. coli* remained the predominant organism in first-time uncomplicated UTIs, with a high prevalence of multidrug resistance and poor susceptibility to several commonly prescribed antibiotics. Nitrofurantoin demonstrated favorable susceptibility and appeared to remain an appropriate option for empiric therapy. Ongoing surveillance of antimicrobial resistance patterns and implementation of antibiotic stewardship programs are essential to guide empiric treatment and reduce the emergence of multidrug resistant organisms.

Keywords: Urinary tract infection, antimicrobial resistance, multidrug resistance, *Escherichia coli*, nitrofurantoin, Iraq.

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1. INTRODUCTION

Urinary tract infections (UTIs) are among the most common bacterial infections in adults all over the world and are a leading cause of primary care visits and outpatient antibiotic prescriptions (1). The clinical impact of UTIs is substantial, accounting for millions of healthcare visits annually for symptoms such as dysuria, urinary frequency, and suprapubic discomfort, which are characteristic of uncomplicated UTIs. Despite being usually mild and self-limiting conditions, they impose great financial burdens on the healthcare system and cause the consumption of antimicrobials due to the high incidence rate (10% positive culture from urine tests in 13,308 Beijing patients over 12 years) (2).

Empiric management is generally initiated at presentation to provide prompt symptom relief and options commonly include trimethoprim/sulfamethoxazole, nitrofurantoin, or fosfomycin (3). Since treatment initiation usually occurs prior to culture results, selection of first-line antibiotics

relies heavily on local susceptibility patterns and resistance rates (4).

Nevertheless, the increasing prevalence of antimicrobial resistance (AMR) has emerged as a major global health concern, with UTIs representing a significant contributor to this trend. Inappropriate prescribing habits, repeated exposure to antibiotics, and unrestricted access to antimicrobials in certain areas have accelerated resistance to commonly prescribed agents (5). Rising resistance rates to trimethoprim/sulfamethoxazole, cephalosporins, fluoroquinolones and even broader-spectrum antibiotics have been reported in various surveillance studies. The clinical implications of these trends are substantial and include treatment failure, recurrent or persistent infections, increased healthcare utilization, and a reduction in the number of effective oral antibiotic options (6).

First-time UTIs warrant separate consideration from recurrent infections because, unlike recurrent cases, they are less likely to have been shaped by prior antibiotic exposure or selection for resistant organisms and therefore

offer a clearer picture of baseline community resistance patterns to guide empiric prescribing for patients presenting for the first time. The patterns of AMR are known to be quite variable across geography, population demographics, and healthcare settings. In outpatient settings where first time UTIs are common and cultures are not routinely obtained, it is uncertain whether international data accurately reflect the local susceptibility patterns in the Kurdistan Region of Iraq (KRI). Furthermore, there is a relative lack of recent, local data describing AMR among adults with a first-time UTI. Establishing baseline AMR profiles in this population is necessary for informing empiric treatment recommendations and guiding public health policy (7)(1). Throughout this manuscript, the terms “simple” and “uncomplicated” UTI are used interchangeably to refer to infections occurring in patients without underlying structural, functional, or immunological abnormalities of the urinary tract.

Recurrent urinary tract infections are one of the major challenges to public health in the KRI. For example, previous studies have reported concerning AMR among adult patients, with *E. coli* demonstrating high levels of resistance to commonly prescribed antibiotics including amoxicillin/clavulanic acid, ampicillin and several cephalosporins (8, 9). In contrast, carbapenems and some aminoglycosides have generally retained good antimicrobial activity against uropathogens (10).

This study aimed to investigate the patterns of antibiotic resistance of uropathogens in adults who present for the first-time with a simple UTI. The specific objectives of this study were: (1) to acquire urine cultures from adult outpatients presenting with symptoms of UTI; (2) to compare culture and sensitivity results with previously published data; and (3) to offer evidence-based recommendations on the first-line use of empiric therapy in this group of patients in the KRI.

Materials and Methods

The study was conducted during a 12-month period between March 2025 and March 2026 in the Duhok Governorate of the KRI. Based on convenience sampling method. A total of five outpatient locations were included: three government primary health centers (PHCs) (Tanahy, Shahidan and Avrocity) and two private outpatient clinics. These sites were chosen to ensure a representative sample of community-acquired, uncomplicated UTI among adults who seek ambulatory care.

Study Population and Sampling

A total of 100 adult patients meeting eligibility criteria were recruited and with a target of 20 participants from each of the five sites. The convenience sampling strategy was employed. The sample size estimation was based on the assumed prevalence of simple UTI of 5%, a 95% confidence level ($Z = 1.96$) and a 5% margin of error. The lowest possible sample size was determined with the use of the formula of n as follows, resulting in 73. To compensate for potential missing or incomplete data, the calculated sample size was first increased by 20% of which was

increased to 88 participations to improve precision as well as to account for potential missing or incomplete data.

$$n = \frac{Z^2 P(1 - p)}{d^2}$$

Because this was a multicenter study involving five healthcare facilities, the recruitment target was further increased beyond the adjusted minimum to 116 participants. This larger target was selected to improve the precision of prevalence estimates, enhance the representativeness of the study population across participating sites, and ensure an adequate number of participants could be enrolled from each site despite possible variations in patient attendance and exclusions during screening.

Eligible participants for the study were adults between the ages of 16 to 80 years, with symptoms of uncomplicated UTI, defined as lower urinary symptoms in the absence of systemic signs and symptoms. Exclusion criteria included antibiotic use within the preceding month, evidence of complicated UTI, a known urological abnormality or complex urological history and current hospitalization.

Data and Specimen Collection

Demographic and clinical data were collected after the informed consent was obtained. All participants provided a midstream clean-catch specimen which was collected using standard aseptic practices. Urine specimens were obtained and submitted for culture prior to the initiation of antimicrobial therapy. For participants who declined to await culture results, nitrofurantoin was offered as empiric treatment.

Questionnaire for Data Collection

A standardized questionnaire was employed for all eligible participants to collect demographic information (including their names, contact numbers, ages, gender, and pregnancy status) and their symptoms including self-reported suspicion of urinary tract infection, absence of vaginal irritation, dysuria (painful urination), lower abdominal discomfort, urinary urgency, increased urinary frequency, hesitancy, and blood in urine.

Microbiological Analysis

Urine specimens were cultured in accordance with each laboratory's standard operating procedure. Isolates were identified and antimicrobial susceptibility testing was performed using standardized methods (e.g. disk diffusion testing or automated systems). The antimicrobial testing panel included antibiotics widely utilized in the treatment of UTIs in KRI.

Laboratory Method

Clinical specimens were inoculated onto Nutrient Agar, MacConkey Agar, and Blood Agar plates and incubated aerobically at 37°C for 24 hours. After incubation, bacterial growth was examined, and a well-isolated colony was selected to obtain a pure culture. A pure bacterial colony was then prepared according to the manufacturer's instructions and loaded into the VITEK® automated

identification and antimicrobial susceptibility testing system. Two VITEK cards were used for each isolate: an identification (ID) card to determine the bacterial species and an antimicrobial susceptibility testing (AST) card to assess the isolate's susceptibility to the selected antibiotics. The VITEK system automatically analyzed the samples and generated the bacterial identification and antibiotic susceptibility profiles.

Data Management and Statistical Analysis

All patient data were de-identified to protect participant confidentiality and ensure anonymity. Laboratory results and patient characteristics were entered into a database for analysis. The statistical tests were conducted using Microsoft Excel. Descriptive statistics were used for demographic characteristics, distribution of pathogens and AMR patterns.

Ethical Considerations

The relevant scientific and ethics committees gave their approval to the study protocol (APPROVAL NO: 1412 DATE: 05/April/2025) in accordance with the institutional requirements. Informed consent was given by all the participants, and the confidentiality of the collected data was maintained.

Results

As shown in Table 1, there were 116 patients enrolled in the study. The mean age was 31.84 years (SD = 11.77; range: 16 -77). Participants aged 18-34 years comprised the largest age group (62.9%). The sample consisted of 87% females, of whom 13.9% were pregnant. Almost all participants (98.3%) reported they believed they had symptoms consistent with UTI. The most commonly reported symptoms were urinary frequency (91.4%), lower urinary tract discomfort (87.9%), urgency (87.8%), pain (69.0%), and hesitancy (51.7%). The least reported symptom was hematuria (7.8%).

Table 1: Demographic characteristics of patients

Characteristics (n=116)	No. (%)
Age (16-77 years) mean (SD)	Std Err Mean: 1.09
Age groups	< 18 years
18-34 years	
35 years and older	8 (6.9)
73 (56.0)	
43 (37.1)	
Gender	Male

Among the 89 positive urine samples analyzed, the highest resistance rates were observed for amoxicillin (75.3%), cefotaxime (71.9%), and azithromycin (67.4%), and amoxicillin/clavulanate (46.1%). Moderate resistance rates were noted for trimethoprim/sulfamethoxazole and

ciprofloxacin (22.5% each). Resistance to nitrofurantoin, levofloxacin and gentamicin was 11.2% each, while the lowest resistance rates were observed for amikacin (6.7%) and imipenem (1.1%) (Table 2)

Table 2: Overall antibiotic resistance among culture-positive urine samples (N=89)

Antibiotic	Resistant n (%)
Amikacin	6 (6.7%)
Amoxicillin/clavulanic acid	41 (46.1%)
Azithromycin	60 (67.4%)
Cefotaxime	64 (71.9%)
Ciprofloxacin	20 (22.5%)
Gentamicin	10 (11.2%)
Imipenem	1 (1.1%)
Levofloxacin	10 (11.2%)
Nitrofurantoin	10 (11.2%)
Trimethoprim/sulfamethoxazole	20 (22.5%)
Antibiotic	Resistant n (%)
Amikacin	6 (6.7%)

Culture results demonstrated that *Escherichia coli* was the predominant organism accounting for 69% of isolates. *Staphylococcus* species accounted for 10%, while *Streptococcus* and *Klebsiella* accounted for 3% and 6%,

respectively. *Proteus* species represented 1% of isolates. In 23.28% of samples, no bacterial growth was observed (Figure 1).

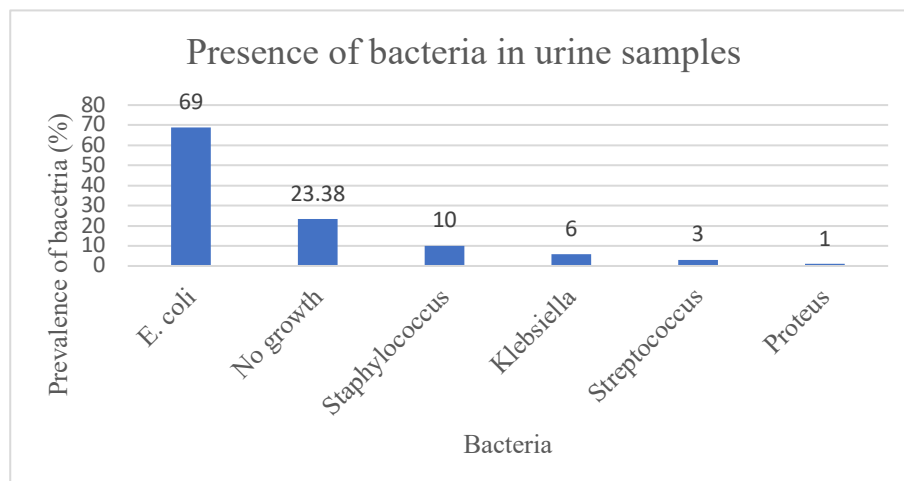


Fig 1: Bacteria found in urine samples of the patients

Resistance to amoxicillin (82.4%), cefotaxime (82.4%), trimethoprim/sulfamethoxazole (38.2%), and ciprofloxacin (35.3%) was significantly related to age ($p < 0.05$), with the highest resistance rates observed among patients aged 35

and older. In contrast, no statistically significant association was found between gender and resistance to any of the antimicrobials evaluated (Table 3).

Table 3: Prevalence of antibiotic resistance according to patient demographic

Characteristics	
Amikacin	Amoxicillin
clavulanic acid	Azithromycin
sulfamethoxazole	
Age (yrs)	< 18
18-34	
≥35	0.0
4.1	
11.8	33.3
75.5	
82.4	33.3
40.8	
55.9	66.7
67.4	
67.7	33.3
69.4	
82.4	0.0
16.3	
35.3	0.0
8.2	
17.7	0.0
0.0	
2.9	0.0

As shown in Table 4, *E. coli* demonstrated high resistance to amoxicillin (78.3%), cefotaxime (72.5%), and azithromycin (71.0%), while resistance to levofloxacin, nitrofurantoin, amikacin, and imipenem remained low.

Staphylococcus exhibited the highest resistance to amoxicillin/clavulanic acid (80%, $p<0.05$). *Klebsiella* and *Streptococcus* species had an intermediate resistance profile across the antibiotics tested

Table 4: Antibiotic resistance according to bacterial species

Antibiotic	Resistance %
	<i>E. coli</i>
Amikacin	7.3
Amoxicillin	78.3
Amoxicillin/clavulanic acid	43.5
Azithromycin	71.0
Cefotaxime	72.5
Ciprofloxacin	20.3
Gentamicin	14.5

Among the 89 culture-positive patients, bacterial isolate distribution was significantly associated with age ($p=0.031$). *E. coli* was the predominant pathogen across all age groups and was most frequently isolated among patients aged 18-34 years (75.5%). The highest proportion of *Klebsiella* was detected in patients aged 35 years and older (17.6%). A significant association was also observed

between gender and isolate distribution ($p=0.027$). *E. coli* was isolated more frequently in females (74.0%) than among males (41.7%), whereas *Staphylococcus* was more likely found among males (33.3%) as compared to females (10.4%). *Klebsiella* was also isolated exclusively in female patients (Table 5)

Table 5. Distribution of Bacterial Isolates by Demographic Characteristics (N=89)

Characteristic	n	<i>E. coli</i> n (%)	<i>Klebsiella</i>
n (%)	Proteus n (%)	Strepto	
-coccus n (%)	Staphylo		
-coccus n (%)	Other n (%)	p-value	
Age group			
	< 18 years	6	3 (50.0)
	18-34 years	49	37 (75.5)
	≥ 35 years	34	22 (64.7)
Gender	Male	12	5 (41.7)

Multi-drug resistance (MDR) was defined as resistance to one or more drugs in 3 or more drug classes. Based on the data presented in Table (6), out of the 84 bacteria

isolated from adult outpatients with UTIs, 53 isolates (59.6%) were categorized as MDR.

Table 6. Multidrug Resistance Rates among Bacterial Isolates from Urine Cultures

Percent of MDR isolates	<i>E.coli</i>	<i>Klebsiella</i>	<i>Proteus</i>	<i>Streptococcus</i>	<i>Staphylococcus</i>	Total
	42/69	3/6	1/1	1/3	6/10	53/84
	60.9 %	50%	100%	33.3%	60%	59.6%

DISCUSSION

In terms of age and clinical features, our study sample is consistent with the typical presentation of uncomplicated urinary tract infection among adults seen in other studies.

The higher proportion of females presenting with UTI can be explained by the well-established epidemiological trends reported in previous studies, highlighting the importance of gender-related considerations in the

development of empiric antibiotic guidelines. Almost all patients reported that they were confident that they had a UTI. Most individuals reported lower urinary tract symptoms which included dysuria, urgency, and increased frequency. Brubaker et al. (2018) demonstrated that the probability of UTI approaches 90% in patients complaining of dysuria and frequency in the absence of vaginal symptoms (11). Collectively, these findings support the value of clinical symptom assessment and local resistance surveillance in order to optimize prescribing empiric antibiotics to individuals showing clinical signs of infection.

Our resistance trends are generally comparable to previous research, though our resistance rates for some important antibiotics have been significantly higher. Although Tesfa et al. (2021) documented similar reduced effectiveness of amoxicillin, cefotaxime, and azithromycin (91%, 65%, and 51%, respectively), this study found higher resistance rates in two of three (75.3%, 71.9%, and 67.4%, respectively), suggesting a greater burden of antimicrobial resistance in our region (2). At the same time, our lowest rates of resistance among study participants – amikacin (6.7%) and imipenem (1.1%) – also matched those in previous research studies done by Tesfa et al. and Bhande-Kolhapure (12, 13). As noted by Bader et al. (2020), resistance rates to trimethoprim/sulfamethoxazole exceeding 20% limit its suitability as an empiric treatment option for UTIs (14). In the present study, the resistance rate was 22.5%, suggesting that trimethoprim/sulfamethoxazole should no longer be used as first-line empiric treatment of UTIs, leaving nitrofurantoin, fosfomycin, and pivmecillinam as first-choice agents in the KRI.

One interesting finding in our study was that 23.3% of the urine samples sent for culture showed no evidence of bacterial growth. This proportion of culture-negative samples is clinically significant and warrants further discussion. Several factors may account for these findings. Although all participants were asked about recent antibiotic use, some individuals may not have accurately recalled or disclosed their antibiotic use and may have been inappropriately included in the study. Additionally, non-bacterial or slow-growing infections, non-genitourinary infections, or non-infectious genitourinary syndromes may have been responsible for their symptoms. This study's negative culture results were slightly lower than the 30% culture-negative rates found in other studies (3), which may have been due to the intentional exclusion in our study of anyone who recently received antibiotic treatment. These results underscore the importance of careful clinical assessment in patients presenting with the first-time UTI, given that urine cultures may be negative despite typical urinary symptoms.

Our study revealed a high prevalence of MDR organisms among the 84 bacterial isolates recovered from adult patients presenting with first-time UTI, with 59.6% meeting criteria for MDR. One concerning consequence

of the rising rates of MDR in first-time UTIs is the growing limitation in empiric treatment options especially since culture results may not be as reliable for first-time UTI as discussed above. This also highlights the importance of continuing to obtain local susceptibility data.

Although pregnancy was not associated with statistically significant differences in AMR compared to nonpregnant women, the observed resistance rates among pregnant women were notably high, particularly for amoxicillin (84.6%) and cefotaxime (84.6%). However, the prevalence of resistance against nitrofurantoin was relatively low at 11.2%, in keeping with the results of Dube et al. (2022), who found that the uropathogens were highly sensitive to nitrofurantoin in their patients. This makes nitrofurantoin ideal for use as the first-line drug in treating first-time UTIs among our pregnant females; nonetheless, care must be taken to avoid using this drug during the third trimester because it may cause neonatal hemolytic anemia due to fetal erythrocyte immaturity (16). The high resistance to cefotaxime is of particular concern because third-generation cephalosporins are commonly used for the treatment of UTIs. This may have further implications for the development of MDR in non-urinary tract infections as well which reinforces the importance of the need for greater antibiotic stewardship here.

Nitrofurantoin with 11.2% resistance rate is still the drug of choice for empiric therapy of uncomplicated lower UTIs, including first-time UTI. Amikacin and imipenem demonstrated the lowest rates of resistance but should only be used for empiric therapy of complicated infections or after cultures confirm they are the best available option. Our findings are consistent with those of Osman et al., who also conducted their study in KRI. They reported high resistance to commonly prescribed antibiotic and found low rates of resistance to amikacin and nitrofurantoin (17). Based on the elevated burden of MDR in this study's region, resistance monitoring programs need to be developed. Additionally, fosfomycin data is unknown in our region and given the rising rates of antibiotic resistance, it is highly advisable that this be included in laboratory testing. The lack of oversight of antibiotic dispensing, including allowing pharmacists to independently dispense without a physician's prescription, is likely contributing to growing AMR and MDR in this region (19) (20).

Beyond the failure of empirical therapy, there are other clinical repercussions of MDR infection, which include delayed cure, development of pyelonephritis or bacteremia, and increased duration of hospital admission (21). All of these pose a significant burden economically as resistant UTIs are known to have increased costs directly linked to medical care, repeated visits, cultures, and hospital admissions, as well as indirectly due to decreased productivity (22). Additionally, the increase in MDR uropathogens is likely to be accompanied by an increase in MDR for pathogens affecting other systems (such as pneumonia). Thus, an antimicrobial

stewardship program based on local antibiogram-directed therapy, restricted non-prescription antibiotic distribution, and audit of prescribers with feedback is highly recommended (23).

LIMITATION

Several limitations of this study should be acknowledged. First, the relatively small sample size of 116 patients, combined with the 23% rate of culture-negative samples, may have limited the statistical power to identify differences in resistance patterns. Additionally, because the majority of isolates were *E. coli*, our findings may not be generalizable to other uropathogens. Convenience sampling only in a few centers may not be representative of all community-acquired UTIs in the KRI. Interviewer bias is also another potential limitation, as some patients may have felt compelled to give an affirmative response when asked if they believed they had a UTI. Male patients were underrepresented in this study and results may not be generalizable to males with first-time UTIs. Although clinical data was collected based on symptoms, treatment success and failure was not tracked so this study is limited in its correlation to patient clinical outcomes. Finally, laboratories in our region did not test for fosfomycin, which is recommended as a first-line treatment of uncomplicated UTIs in several international guidelines.

CONCLUSION

The diagnosis and treatment of first-time uncomplicated UTIs should be primarily guided by clinical symptoms, urine cultures are frequently negative in this population. The growing prevalence of MDR uropathogens highlights the importance of appropriate antibiotic selection. Nitrofurantoin remains a recommended empiric treatment option, especially in pregnant women. In contrast, trimethoprim/sulfamethoxazole should be avoided as first-line empiric treatment in the KRI. Although fosfomycin was not evaluated in our study, evidence from other studies support its use as first-line empiric treatment. Given the decreasing number of viable options for empiric UTI treatment, susceptibility testing for fosfomycin should be incorporated into routine laboratory surveillance programs. Greater emphasis is needed in promoting antimicrobial stewardship in the KRI to preserve the effectiveness of available treatment and slow or even reverse the increase in MDR organisms

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