Urinary Tract Infections in a Tertiary Care Hospital in Al-Baha, Saudi Arabia

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ABSTRACT

Urinary tract infections (UTIs) represent one of most common infectious diseases worldwide and are increasingly complicated by antimicrobial resistance and recurrent infection, particularly in elderly and hospitalized populations. Data from several regions of Saudi Arabia, including Al-Baha, remain limited despite a high national disease burden. A retrospective cross-sectional analysis was conducted on 804 consecutive urine culture records obtained from symptomatic inpatients and outpatients attending a tertiary care hospital in Al-Baha, Saudi Arabia, between September 2023 and January 2025. Midstream and catheter urine samples were cultured using standard microbiological techniques. Pathogen identification and antimicrobial resistance profiling were performed using the VITEK-2 Compact automated system. Demographic variables, clinical setting (inpatient vs. outpatient), microbial distribution, antimicrobial resistance phenotypes (including ESBL and carbapenem resistance), recurrence patterns, and documented comorbidities were analyzed using descriptive statistical methods. Of the 804 isolates analyzed, 540 (67.2%) were from inpatients and 264 (32.8%) from outpatients. Females constituted the majority of cases, and more than half of patients were aged >65 years. Escherichia coli was the predominant uropathogen (31.4%), followed by ESBL-producing E. coli (14.4%), Klebsiella pneumoniae (12.9%), ESBL- and carbapenem-resistant Klebsiella species (13.8% combined), Pseudomonas aeruginosa (4.8%), and Candida species (~7%). Antimicrobial-resistant isolates accounted for 28.2% of all cultures, with significantly higher resistance among inpatients (31.7%) compared with outpatients (21.2%). ESBL-producing E. coli represented the most frequent resistant phenotype overall. Recurrent infection episodes constituted 40.2% of culture records, corresponding to 14.8% of unique patients, predominantly affecting elderly (>65 years) and female patients. Among diagnosed inpatients, diabetes mellitus (17.7%) and chronic kidney disease (15.2%) were the most frequent comorbid conditions. UTIs in the Al-Baha region are characterized by a high burden of antimicrobial resistance and recurrence, particularly among hospitalized and elderly patients. The predominance of ESBL- and carbapenem-resistant Enterobacterales underscores the urgent need for strengthened antimicrobial stewardship, continuous resistance surveillance, and targeted preventive strategies for high-risk populations.

INTRODUCTION

Globally, urinary tract infections (UTIs) represent one of the most prevalent infections, with approximately 405 million cases per year[1]. They are associated with reduced quality of life, and their clinical and economic burden is considerable[2]. Whether in community or healthcare settings, UTIs have a significant adverse impact on public health. They are the most frequent outpatient infections and are more common in women than in men, as up to half of adult women will experience a UTI during their lifetime[3,4]. In hospital settings, healthcare-associated UTIs account for up to 9.4% of infections[3].

UTIs are diverse in terms of aetiology, clinical presentation, and disease course, ranging from simple cystitis and urethritis to more severe conditions such as pyelonephritis, bacteraemia, and septic shock[5]. The causative agents vary over time and across geographical regions[6]. Moreover, differences in virulence factors and the emergence of multidrug-resistant pathogens contribute significantly to the pathogenicity and treatment challenges of uropathogens[7]. Despite advances in diagnosis and management, UTIs remain a public health concern, with a mortality rate of up to 2.3% and an annual cost of approximately $450 million in the United States[8,9].

In Saudi Arabia, UTIs represent a substantial public health burden, accounting for approximately 10% of all infections and ranking as the second leading cause of emergency department admissions[10]. According to Global Burden of Disease 2021 estimates, Saudi Arabia has one of the highest UTI-related mortality burdens in the Middle East and North Africa, with an age-standardised mortality rate of 6.2 deaths per 100,000 population, corresponding to approximately 2,000 deaths annually[10]. Several comorbidities are associated with UTIs, including diabetes, hypertension, chronic kidney disease, heart disease, recurrent UTIs, sleep disorders, irritable bowel syndrome, and neurological conditions[11].

Despite existing research, some regions of Saudi Arabia remain underrepresented in the literature[12]. Therefore, this study aims to investigate the aetiology and associated comorbidities of UTIs across different age groups in the Al-Baha population. This may contribute to improved understanding and management of UTIs in this region.

MATERIALS AND METHODS

Study design, setting, and subjects: This is a retrospective cross-sectional study which included urine culture results of patients visiting tertiary hospital in Al-Baha, Saudi Arabia, with signs and symptoms of urinary tract infections. The hospital is designated as a general hospital by Al-Baha health cluster under supervision of the ministry of health. It is one of the largest hospitals in the Al-Baha region, with a capacity of over 250 beds. It serves the people of the seven governates of the Al-Baha region.

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The study was conducted in accordance with the Declaration of Helsinki, and approved by the Research Ethics and Advisory Committees of the College of Medicine, Al-Baha University (approval number: IRB/MIC/BU-FM/2024/180).

Informed Consent Statement: Not applicable.

Sampling: Data were collected from hospital laboratory record sheets for both inpatients and outpatients during the study period from September 2023 to January 2025. Midstream and catheter stream urine samples were obtained from these recorded cases. The microbial urinary tract infections records and its associated comorbidities as well as the demographic data of the patients in addition to the rate of microbial resistant organisms causing UTIs were included in the study and the negative culture results were excluded. These consisted of 804 urine specimens that were assembled consecutively from individuals who presented with signs and symptoms of urinary tract infection and were referred for microbiological investigations. All eligible samples collected during the study period were included without prior sample size calculation.

Culture and laboratory investigation: Urine Samples were cultured on Cystine-Lactose-Electrolyte-Deficient (CLED) agar, MacConkey agar, and blood agar. Cultures were incubated overnight aerobically at 35-37 °C. Sabouraud dextrose agar was used for fungal cultures which were incubated at 30°C. From the cultures, microbial suspensions were performed using 3 mL of sterile saline (0.45-0.50% NaCl). Then, the organism and antibiotic susceptibility profile was identified using VITEC Densicheck according to manufacturer instructions with determining suspension turbidity of 0.5 McFarland.

Laboratory investigation: Confirmative identification of the bacterial isolates was done via VITEK-2 computational system (bioMérieux, France). It is an automated microbiology system which employs growth-based technology that encompasses colorimetric reagent cards incubated and interpreted automatically[13]. The VITEK-2 Compact system enables the identification of bacterial and fungal isolates and determines their response to various antimicrobials. When tested, it showed 95.8% concordance with the reference API strips (bioMérieux, France) in identifying Gram-positive cocci, Gram-negative rods, and yeast. Its accuracy further increased to 98.3% with the addition of confirmatory tests[13].

Statistical analysis: Microbiological, clinical, and demographic data of patients were coded, entered, and analyzed using Python (statsmodels v0.14, SciPy v1.13, and Matplotlib v3.7) with artificial intellegence assistance using ChatGPT. Quantitative analysis with mean and standard deviation was used to describe continuous variables, while absolute and relative frequencies were used to summarize categorical variables.

RESULTS

Demographic Characteristics

A total of 804 patients were included in this analysis, comprising 540 inpatients (67.2%) and 264 outpatients (32.8%). The cohort demonstrated a predominance of female patients, followed by males. The distribution of age was assessed using the Shapiro-Wilk test and was found not to be normal ($p < 0.05$). Therefore, age is presented as the median and interquartile range (IQR). The median age of participants was 67.0 years (range: 1-114 years) with the majority belonging to the <65 years age group (Table 1).

Table 1. Age groups of the infected individuals.

Age group years	n (%)
1-18	161 (20.0)
18 - 40	92 (11.5)
41 - 65	115 (14.3)
>65	436 (54.2)

Table 2. Most common microbial isolates combined

Organism	n (%)
Escherichia coli	253 (31.4)
Escherichia coli (ESBL)	116 (14.4)
Klebsiella pneumoniae	104 (12.9)
Klebsiella pneumoniae (ESBL)	57 (7.1)
Klebsiella pneumoniae (CRE)	54 (6.7)
Pseudomonas aeruginosa	39 (4.8)
Candida albicans	34 (4.2)
Enterococcus faecalis	33 (4.1)
Proteus mirabilis	29 (3.6)
Staphylococcus saprophyticus	21 (2.6)
Citrobacter freundii	18 (2.2)
Morganella morganii	12 (1.5)
Candida tropicalis	11 (1.4)
Staphylococcus aureus	11 (1.4)
Enterobacter cloacae	9 (1.1)
Staphylococcus aureus (MRSA)	6 (0.7)

Microbial Isolates

Across all positive cultures, *Escherichia coli* was the most commonly isolated pathogen, followed by *Klebsiella* spp., *Pseudomonas aeruginosa* and *Candida* albican, (Table 2). These findings mirror global and regional trends in community- and hospital-acquired urinary infections. The predominance of *E. coli* suggests a major contribution from lower urinary tract infections of enteric origin, while the identification of *Klebsiella* and *Pseudomonas* indicates more complex or healthcare-associated infections.

When stratified by clinical setting, inpatients exhibited greater microbial diversity, including higher frequencies of *Candida* spp. and multidrug-resistant Gram-negative organisms**.** Whereas outpatients showed a predominance of *E. coli* and other Enterobacteriaceae (Table 3). This divergence reflects the difference between community-acquired infections and hospital-associated colonization or secondary infection patterns.

Other*: organisms with single isolates (0.2% in-patients and 0.4% out-patients). In in-patients, those were Streptococcus spp, Enterobacter spp, Citrobacter spp, Providencia spp, Candida parapsilosis, Candida glabrata, Candida duobushaemulonii, Candida laurentii, Candida lusitaniae, mixed growth (E. coli + Proteus), mixed growth (E. coli + Klebsiella), and VRE (unspecified species). Out-patients were: Staphylococcus haemolyticus, Staphylococcus spp (unspecified), Micrococcus spp, Streptococcus spp (unspecified), Citrobacter koseri, Serratia marcescens, and Candida famata.

Anti-microbial resistant isolates

For 804 patient UTI isolates detected, 227 (28.2%) were identified as antimicrobial-resistant strains, including extended-spectrum β-lactamase (ESBL)–producing and carbapenem-resistant Enterobacterales (CRE). The majority of these organisms were *Escherichia coli* and *Klebsiella* strains that constituted more than 95%

Table 3. In-patients vs Out-patients Organism Distribution (Rearranged)

Organism	In-patients n (%)	Out-patients n (%)
E. coli	142 (26.3%)	114 (43.2%)
E. coli ESBL	81 (15.0%)	40 (15.2%)
Klebsiella spp	72 (13.3%)	35 (13.3%)
Klebsiella CRE	50 (9.3%)	3 (1.1%)
Klebsiella ESBL	45 (8.3%)	14 (5.3%)
Candida albicans	34 (6.3%)	1 (0.4%)
Pseudomonas spp	23 (4.3%)	4 (1.5%)
Proteus spp	19 (3.5%)	13 (4.9%)
Enterococcus spp	16 (3.0%)	4 (1.5%)
Candida tropicalis	11 (2.0%)	—
Proteus ESBL	9 (1.7%)	2 (0.8%)
E. coli CRE	5 (0.9%)	—
Staphylococcus aureus (MSSA)	4 (0.7%)	6 (2.3%)
Staphylococcus saprophyticus	4 (0.7%)	2 (0.8%)
Candida auris	4 (0.7%)	—
Enterococcus faecalis	3 (0.6%)	11 (4.2%)
MRSA	3 (0.6%)	3 (1.1%)
Other*	11 (2.0%)	13 (4.9%)

Table 4. Most Common Co-morbidities among diagnosed inpatients

Diagnosis	n	% (of diagnosed inpatients)
Only UTI	40	50.7
Diabetes + UTI	14	17.7
CKD + UTI	12	15.2
Asthma + UTI	5	6.3
Stroke + UTI	5	6.3
Hypertension + UTI	3	3.8

Table 5. Recurrent UTI episodes among different age groups

Age Group	Recurrent episodes n(%)
<18 years	36 (11.1%)
18–40 years	13 (4.0%)
41–65 years 29 9.0%	29 (9.0%)
65 years	156 (48.3%)
Age not recorded	89 (27.6%)

of all resistant isolates. Among the in-patient cohort (n = 540 isolates), resistant strains have been detected in 171 cases (31.7%) that were led by E. coli ESBL (21.7%), Klebsiella ESBL (10.6%), and Klebsiella CRE (9.8%). This distribution mirrors the high antimicrobial pressure, device exposure, and comorbidity burden required during hospitalization. By contrast, the outpatient cohort (n = 264 isolates) had 56 isolates resistant (21.2%); the majority of the isolates produced were *E. coli* ESBL (18.9%), with much lower count of *Klebsiella* ESBL or CRE detections. In total, *E. coli* ESBL was the most common resistant organism, having generated 117 (14.5%) isolates, followed by *Klebsiella* ESBL (7.1%) and *Klebsiella* CRE (6.6%) isolates. These findings emphasize the higher rates of ESBL-mediated resistance in urinary pathogens, and they underscore the considerable disparity in the community versus the hospital setting, and the need for focused antimicrobial-stewardship interventions in the inpatient setting.

Diagnosed Inpatients

Among the inpatient cohort, 79 patients (14.6%) had a documented diagnosis beyond microbiological findings (Table 4). The most frequent diagnoses were UTI (45.6%), diabetes (17.7%), and chronic kidney disease (15.2%), followed by asthma (6.3%), stroke (6.3%), infection (5.1%), and hypertension(3.8%). The clustering of diabetes and CKD within the inpatient cohort highlights the clinical interplay between metabolic and renal disease in predisposing to recurrent or complicated urinary infections. This observation underscores the importance of early glycemic control and renal function monitoring as part of infection prevention and stewardship programs in hospitalized populations.

Recurrent UTI

Recurrent UTI is typically defined as two or more episodes within six months or three or more episodes within twelve months. Recurrence in this study was inferred from repeated urine culture records linked to the same patient identifier in the absence of detailed clinical data, which may not fully reflect true clinical recurrence. Recurrence of infection episodes was more frequent among female patients who accounted for 153 episodes (47.4%), compared with 81 episodes (25.1%) in males. However, there are recurrent infection episodes where gender was not documented and those were 89 episodes (27.6%) (Table 5). Age stratification demonstrated a marked predominance of recurrence among elderly patients, with 156 episodes (48.3%) occurring in individuals aged >65 years, followed by 41–65 years (9.0%), <18 years (11.1%), and 18–40 years (4.0%). These findings indicate that recurrent urinary infections in this cohort were concentrated among older adults and females, consistent with known demographic risk profiles. Nearly half of all recurrent infection episodes occurred in patients older than 65 years, highlighting advanced age as a major contributor to recurrence risk. Pediatric and young adult recurrence was comparatively uncommon.

DISCUSSION

Urinary tract infection (UTI) represents one of the most prevalent microbial infections despite advances in diagnostic approaches, antimicrobial therapy, and enhanced understanding of its underlying pathogenesis. First-line treatment of UTI usually succeeds in eradicating bacterial colonisation and preventing infection initiation. Nonetheless, in certain high-risk groups—such as the elderly, diabetic patients, pregnant women, kidney transplant recipients, and patients with pre-existing structural abnormalities of the urinary tract, microorganisms may persist and establish infection within the urinary tract[14]. Patients with recurrent UTI episodes are often prescribed antibiotics repeatedly or empirically. As a result, antimicrobial resistance in UTI treatment is increasing rapidly, highlighting the need for strengthened antimicrobial stewardship and updated management strategies[15,16].

In our study, *Escherichia coli* was the main causative agent of UTI, followed by *Klebsiella* spp., *Pseudomonas aeruginosa*, and *Candida albicans*. This pathogen distribution correlates with findings reported in regional studies from Saudi Arabia[17,18]. While *E. coli* remains the most prevalent uropathogen across studies, confirming its central role in UTIs, we observed a markedly high prevalence of ESBL-producing *E. coli* and *Klebsiella pneumoniae* aligned with studies by Balkhi B et al. and Alzahrani et al.[17,18]. This likely reflects a greater burden of antimicrobial resistance in our study population. Additionally, carbapenem-resistant *K. pneumoniae* and fungal pathogens (*Candida* spp.) were detected in our cohort but were not reported in Alzahrani et al.[18], possibly due to differences in patient demographics, healthcare exposure, or antimicrobial use. In contrast, Alzahrani et al.[18], found that *Enterococcus faecalis* was isolated more frequently, which may be attributed to differences in patient populations, particularly a higher proportion of community-acquired infections and lower exposure to broad-spectrum antibiotics, as *Enterococcus* species are more commonly associated with uncomplicated UTIs and less selective antibiotic pressure.

This study shows that antimicrobial-resistant isolates were more frequent among inpatients than outpatients, consistent with prior evidence indicating that healthcare-associated UTIs—particularly catheter-associated infections—are enriched with multidrug-resistant organisms compared with community-acquired UTIs[15]. Inpatient cohorts are expected to have prior antibiotic exposure, indwelling urinary devices, and repeated healthcare contact, which increase the selection and transmission of resistant hospital-associated organisms[16]. Diabetes mellitus was one of the most common comorbidities associated with UTI in this study, accounting for 17.7% of diagnosed inpatient cases. This finding is supported by multiple studies and may be explained by impaired immune responses and poor glycaemic control among diabetic patients[19-22].

Regarding demographic characteristics, females and individuals aged over 65 years were the most affected groups. This increased susceptibility may be attributed to hormonal changes such as oestrogen deficiency, anatomical vulnerability, and age-related decline in immune defence mechanisms[14]. With respect to recurrence, 323 samples (40.2%) were obtained from 119 patients (14.8%) with evidence of recurrent infection. Recurrence was more frequent among female patients, accounting for 153 episodes (47.4%), compared with 81 episodes (25.1%) in males, while 89 episodes (27.6%) lacked documented gender information. The high proportion of recurrent UTIs among elderly and female patients highlights the multifactorial nature of recurrence, involving immune senescence, hormonal fluctuations, anatomical susceptibility, and repeated antibiotic exposure. These trends align with regional epidemiological data demonstrating a higher incidence of UTIs among older adult females in Saudi Arabia[17]. A cross-sectional study conducted among female residents in Ha'il, Saudi Arabia, similarly reported significantly higher UTI prevalence in older age groups[23].

Additionally, behavioural and social factors significantly increase the likelihood of UTIs in older individuals, particularly women. Reduced mobility may result in incomplete bladder emptying and urinary stasis, while dehydration—common in the elderly—reduces urinary flow and bacterial clearance. Cognitive impairment and age-related functional decline further contribute through poor perineal hygiene, urinary incontinence, and increased dependence on caregivers. These factors are especially prevalent in long-term care facilities, resulting in a disproportionately higher burden of UTIs among older women compared with men[24,25].

Limitations of the Study

Several limitations should be considered, even though this study offers insightful information about the epidemiology of urinary tract infections (UTIs) and patterns of antibiotic resistance in both inpatient and outpatient settings. Retrospective, Laboratory-Driven Design:

The analysis relied on microbiology laboratory records without standardised clinical criteria for differentiating between asymptomatic bacteriuria and UTI or clinical adjudication of symptoms. True clinical infections may be overestimated or incorrectly classified as a result of this design.

Constraints on Recurrence Definition

Instead of using clinically defined recurrence (e.g., ≥2 episodes within 6 months or ≥3 within 12 months), recurrent infection episodes were inferred from repeated culture entries. The intricate dynamics of clinical recurrence might not be adequately captured by this operational definition.

Incomplete Antimicrobial Susceptibility Detail

While resistance categories in a large sample (ESBL, CRE, etc.) were present in the dataset, there are no antibiotic-specific susceptibility profiles, such as susceptibility to fluoroquinolone or nitrofurantoin. These restrictions prevent translating their results directly into empirical guidelines for treatment recommendations.

Missing Demographic and Clinical Variables

Incomplete demographic information (e.g., gender) or other clinical factors including comorbidity severity, previous antibiotic use, history of urinary tract instrumentation, or urinary catheter presence were missing in some of the records. Absence of these parameters limits more complex risk factor analysis.

Potential Selection Bias

The data are from patients whose specimens were submitted for culture, which might be biased in favor of those with more severe symptoms or at high risk. Cases with asymptomatic or community managed UTIs without cultures may also be undercounted. However, the large dataset size and combination of outpatient and inpatient measurements contribute to the generalizability of patterns of antibiotic resistance and demographic associations.

CONCLUSION

In summary, the study describes the epidemiology and resistance of urinary tract infections in a large clinical database and provided useful information on key patterns of pathogen distribution, recurrent infection events, and antimicrobial resistance. Most common pathogens in the outpatient and inpatient areas were *Escherichia coli* and *Klebsiella* species; elderly and female patients presented greater recurrence and resistant isolates. High ESBL and CRE phenotypes, especially among inpatient samples, highlight the urgent need of robust antimicrobial stewardship strategies, as well as routine monitoring. Clinicians need to be alert and careful about the choice of empirical therapy, even more particularly in high-risk populations such as older adults and individuals with past UTIs or comorbidities such as diabetes and chronic kidney disease. This emphasizes the need for future prospective studies that use clinical symptomatology, standardized recurrence criteria, and antibiotic exposure histories to improve risk stratification and optimize therapeutic pathways and to inform local policy concerning UTI diagnosis and management. These may improve patient outcomes as well as mitigate the burden of antimicrobial resistance in urinary pathogens.

Authorship Contribution: All authors share equal effort contribution towards (1) substantial contributions to conception and design, acquisition, analysis and interpretation of data; (2) drafting the article and revising it critically for important intellectual content; and (3) final approval of the manuscript version to be published. Yes.

Potential Conflicts of Interest: None

Competing Interest: None

Acceptance Date: 01April, 2026

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