Original Article

Bacteriological Profile of Urinary Tract Infection and Their Antimicrobial Susceptibility Pattern in View of Emerging Drug Resistance

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Abstract

Background: Urinary tract infection (UTI) remains one of the most common bacterial infections affecting all age groups worldwide. The increasing emergence of antimicrobial resistance among uropathogens has become a major public health concern, limiting therapeutic options and increasing morbidity and healthcare costs. Continuous surveillance of causative organisms and their antimicrobial susceptibility patterns is essential for guiding empirical treatment.

Objective: To determine the bacteriological profile of urinary tract infections and evaluate the antimicrobial susceptibility patterns of isolated pathogens in relation to emerging antimicrobial resistance.

Methods: This retrospective cross-sectional study analyzed urine culture and sensitivity reports collected during January, 2023 to December, 2025. A total of 1,944 urine samples from patients of different age groups were evaluated. Bacterial isolates were identified using standard microbiological techniques. Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method according to standard laboratory guidelines. Data were analyzed according to age group, gender distribution, bacterial profile, and antibiotic susceptibility pattern.

Results: Among 1,944 urine samples, 475 were culture-positive, giving an overall prevalence of 24.43%. Females demonstrated a higher infection rate (26.24%) than males (19.96%). The highest prevalence of UTI was observed among children aged 0–10 years (56.25%) and individuals aged ≥51 years (47.4%). *Escherichia coli* was the predominant pathogen across most age groups, particularly among adults and elderly patients. *Enterococcus, Staphylococcus, Klebsiella,* and *Pseudomonas* species were also identified. Imipenem, Meropenem, Amikacin, and Nitrofurantoin exhibited comparatively higher sensitivity rates, whereas Cephradine, Cefixime, Ceftazidime, Ceftriaxone, Moxifloxacin, and Amoxicillin-Clavulanic acid demonstrated high resistance levels. Multidrug resistance was observed across several bacterial isolates.

Conclusion: *Escherichia coli* remains the leading cause of urinary tract infections. High resistance rates against commonly prescribed antibiotics highlight the growing challenge of antimicrobial resistance. Carbapenems, Amikacin, and Nitrofurantoin retained better activity against uropathogens and may be considered for empirical therapy based on local susceptibility patterns.

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Introduction

Urinary tract infection (UTI) is one of the most common bacterial infections affecting individuals of all age groups and remains a major public health concern worldwide. It encompasses infections involving any part of the urinary system, including the urethra, urinary bladder, ureters, and kidneys. UTIs are responsible for substantial morbidity and healthcare utilization, accounting for millions of outpatient visits, emergency consultations, and hospital admissions annually. Although UTIs may occur in both sexes, women are particularly susceptible due to anatomical and physiological factors such as a shorter urethra, proximity of the urethral opening to the anus, sexual activity, pregnancy, and hormonal changes. Children, elderly individuals, diabetic patients, and those with urinary tract abnormalities are also at increased risk of developing urinary tract infections.[1,2] Globally, it is estimated that more than 150 million cases of UTI occur each year, resulting in significant healthcare costs and reduced quality of life among affected individuals.[3] In developing countries, the burden of UTI is further compounded by limited access to diagnostic facilities, inadequate infection control measures, and widespread misuse of antimicrobial agents. If left untreated or inadequately managed, UTIs may progress to severe complications such as pyelonephritis, renal abscess, septicemia, chronic kidney disease, and recurrent infections. Therefore, early diagnosis and appropriate antimicrobial therapy are crucial for preventing adverse outcomes and reducing disease burden.[4] The spectrum of microorganisms responsible for urinary tract infections varies according to patient characteristics, geographic region, healthcare setting, and underlying risk factors. However, *Escherichia coli* remains the predominant causative pathogen worldwide and is responsible for approximately 70–90% of uncomplicated community-acquired UTIs. The high prevalence of *Escherichia coli* is attributed to its ability to adhere to uroepithelial cells through specific virulence factors, facilitating colonization and invasion of the urinary tract.[5] Other important uropathogens include *Klebsiella* species, *Enterococcus* species, *Staphylococcus* species, *Proteus* species, *Pseudomonas aeruginosa*, *Enterobacter* species, and *Acinetobacter* species.[6] The distribution of these pathogens may differ between community-acquired and hospital-acquired infections and can be influenced by patient demographics and local epidemiological factors. Over the past two decades, antimicrobial resistance among uropathogens has emerged as a major challenge to the effective management of urinary tract infections. The extensive and often inappropriate use of antibiotics has accelerated the development and spread of resistant bacterial strains, leading to reduced efficacy of commonly prescribed antimicrobial agents. Resistance to fluoroquinolones, cephalosporins, penicillins, and trimethoprim-sulfamethoxazole has increased significantly in many parts of the world, limiting treatment options and contributing to therapeutic failures.[7,8] Furthermore, the emergence of multidrug-resistant (MDR), extended-spectrum beta-lactamase (ESBL)-producing, and carbapenem-resistant organisms has become an alarming public health issue, particularly in low- and middle-income countries.[9]Knowledge of local bacteriological profiles and antimicrobial susceptibility patterns is essential for guiding empirical treatment and developing evidence-based antibiotic stewardship programs. Because resistance patterns vary considerably across regions and healthcare facilities, regular surveillance studies are necessary to monitor changing trends and ensure effective management of UTIs.[10] Such information assists clinicians in selecting appropriate antimicrobial agents, reduces unnecessary antibiotic exposure, and helps limit the further emergence of resistance. In Bangladesh and other South Asian countries, data regarding age-specific bacteriological profiles and antimicrobial susceptibility patterns remain limited. Continuous evaluation of local resistance trends is therefore important for optimizing therapeutic strategies and improving patient outcomes. The present study was conducted to determine the bacteriological profile of urinary tract infections among different age groups and to evaluate the antimicrobial susceptibility patterns of isolated uropathogens, with particular emphasis on emerging antimicrobial resistance. The findings of this study are expected to contribute valuable information for clinicians, microbiologists, and policymakers involved in the prevention and management of urinary tract infections.

Methods

Study Design and Setting

This retrospective cross-sectional study was conducted to determine the bacteriological profile of urinary tract infections (UTIs) and evaluate the antimicrobial susceptibility patterns of isolated uropathogens. The study was based on laboratory records of urine culture and sensitivity reports collected during the period from January 2023 to December 2025. All microbiological investigations were performed in Dinajpur Medical College Microbiology laboratory following standard operating procedures (CLSI). The study included patients of all age groups and both sexes who were clinically suspected of having urinary tract infections and underwent urine culture examination.

Study Population and Sample Size

A total of 1,944 urine samples submitted for culture and sensitivity testing during the study period were reviewed. Among these, 475 samples showed significant bacterial growth and were considered culture-positive for UTI. Patients were categorized into six age groups: 0–10 years, 11–20 years, 21–30 years, 31–40 years, 41–50 years, and ≥51 years. Demographic information including age and gender was obtained from laboratory records.

Inclusion and Exclusion Criteria

All urine samples with complete microbiological and antimicrobial susceptibility data were included in the study. Samples demonstrating significant bacteriuria according to standard microbiological criteria were considered positive. Duplicate samples from the same patient, contaminated specimens, mixed growth indicating improper collection, and records with incomplete laboratory information were excluded from the analysis.

Sample Collection and Processing

Midstream clean-catch urine specimens were collected in sterile, wide-mouthed containers following standard aseptic procedures. For pediatric and critically ill patients, urine samples were collected according to accepted clinical protocols. Specimens were transported promptly to the microbiology laboratory and processed within the recommended time period to minimize contamination and bacterial overgrowth.

Isolation and Identification of Bacterial Pathogens

Urine specimens were inoculated onto appropriate culture media using a calibrated wire loop and incubated aerobically at 35–37°C for 18–24 hours. Significant bacteriuria was determined based on colony count criteria. Bacterial isolates were identified by colony morphology, Gram staining characteristics, and conventional biochemical tests, including catalase, coagulase, oxidase, citrate utilization, indole production, urease activity, and carbohydrate fermentation reactions where applicable.

Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method on Mueller–Hinton agar. The antibiotics tested included Cephradine, Co-trimoxazole, Ciprofloxacin, Nitrofurantoin, Nalidixic Acid, Ceftriaxone, Amoxicillin–Clavulanic Acid, Ceftazidime, Gentamicin, Cefotaxime, Cefuroxime, Amikacin, Azithromycin, Imipenem, Cefepime, Vancomycin, Meropenem, Cefixime, Moxifloxacin, Linezolid, Tigecycline, Levofloxacin, and Piperacillin–Tazobactam. Results were interpreted as Sensitive (S), Intermediate (I), or Resistant (R) according to the current Clinical and Laboratory Standards Institute (CLSI) guidelines.

Data Analysis

Data were entered, cleaned, and analyzed using Microsoft Excel and Statistical Package for Social Sciences (SPSS) software version 26. Descriptive statistics were used to summarize demographic characteristics, prevalence of UTI, distribution of bacterial isolates, and antimicrobial susceptibility patterns. Results were presented as frequencies, percentages, tables, and charts where appropriate. Age-wise and gender-wise analyses were performed to identify trends in infection rates and antimicrobial resistance patterns among different population groups.

Ethical Considerations

The study utilized anonymized laboratory data without direct patient contact. Confidentiality of patient information was strictly maintained throughout the study. All data were analyzed solely for academic and research purposes in accordance with ethical principles governing biomedical research.

Results

A total of 1,944 urine samples were analyzed during the study period, of which 475 were culture-positive, yielding an overall UTI prevalence of 24.43%. The highest prevalence was observed among children aged 0–10 years (56.25%), followed by individuals aged ≥51 years (47.4%). Female patients accounted for the majority of UTI cases (363/475, 76.4%), while male patients represented only 23.6% (112/475). Female predominance was observed in nearly all age groups except the elderly population, where infection rates were comparatively similar between sexes.

Table I: Distribution of UTI According to Age Group and Gender

Age Group (Years)	Total Samples	Culture Positive	Prevalence (%)	Male Positive	Female Positive
0–10	16	9	56.25	4	5
11–20	46	21	45.6	6	15
21–30	87	32	36.8	8	24
31–40	74	28	37.8	8	20
41–50	101	42	41.6	11	31
≥51	154	73	47.4	39	34
Total	1944	475	24.43	112	363

Table II: Distribution of Uropathogens According to Age Groups

Organism	0–10 yrs	11–20 yrs	21–30 yrs	31–40 yrs	41–50 yrs	≥51 yrs	Total
Escherichia coli	2	3	16	16	21	36	94
Enterococcus spp.	2	6	6	4	10	16	44
Staphylococcus spp.	3	8	5	5	5	7	33
Klebsiella spp.	1	4	5	3	6	8	27
Pseudomonas spp.	1	0	0	0	0	6	7

Escherichia coli was the predominant pathogen isolated from urine cultures, accounting for 94 isolates and representing the major causative organism across all adult age groups. The highest number of *Escherichia coli* infections was observed among patients aged ≥51 years (36 isolates), followed by those aged 41–50 years (21 isolates). *Enterococcus* spp. constituted the second most common isolate (44 isolates), while *Staphylococcus* spp., *Klebsiella* spp., and *Pseudomonas* spp. were isolated less frequently. *Pseudomonas* infections were predominantly observed in elderly patients.

Table III: Most Effective Antimicrobial Agents Against Uropathogens

Antibiotic	Sensitivity Range (%)
Imipenem	66.7–90.5
Meropenem	44.4–71.9
Amikacin	52.4–71.4
Nitrofurantoin	44.4–68.8
Gentamicin	33.3–60.7

Among the tested antibiotics, Imipenem demonstrated the highest antimicrobial activity across all age groups, with sensitivity ranging from 66.7% to 90.5%. Meropenem and Amikacin also exhibited favorable susceptibility profiles, particularly among Gram-negative isolates. Nitrofurantoin maintained good effectiveness against common urinary pathogens and showed consistent activity across different age categories. Gentamicin demonstrated moderate susceptibility and remained effective against a substantial proportion of isolates.

Table IV: Antimicrobial Agents Showing Highest Resistance

Antibiotic	Resistance Range (%)
Moxifloxacin	88.9–98.6
Cefixime	88.9–95.2
Cephradine	61.9–90.4
Ceftazidime	75.7–95.2
Ceftriaxone	75.0–81.2
Amoxicillin-Clavulanic Acid	66.7–88.9

Marked resistance was observed against several commonly prescribed antibiotics. Moxifloxacin exhibited the highest resistance rate, exceeding 90% in most age groups. Similarly, Cefixime, Cephradine, Ceftazidime, and Ceftriaxone demonstrated poor activity against urinary isolates. Resistance to Amoxicillin-Clavulanic Acid was also high, suggesting limited usefulness of these agents for empirical treatment of urinary tract infections in the study population.

Table V: Overall Antimicrobial Resistance Pattern

Antibiotic Group	Overall Interpretation
Carbapenems (Imipenem, Meropenem)	Highest sensitivity
Aminoglycosides (Amikacin, Gentamicin)	Moderate to high sensitivity
Nitrofurantoin	Good sensitivity
Fluoroquinolones (Ciprofloxacin, Levofloxacin, Moxifloxacin)	High resistance
Cephalosporins	Very high resistance
Macrolides (Azithromycin)	Poor sensitivity

The overall susceptibility pattern demonstrated substantial antimicrobial resistance among urinary pathogens. Carbapenems remained the most effective therapeutic agents, while aminoglycosides retained moderate effectiveness. Nitrofurantoin continued to show favorable activity against most isolates and may be considered a useful option for uncomplicated UTIs. In contrast, fluoroquinolones, cephalosporins, and macrolides exhibited high resistance rates, reflecting the growing challenge of multidrug resistance among uropathogens. These findings emphasize the need for culture-guided therapy and continuous antimicrobial surveillance.

Discussion

The present study investigated the bacteriological profile of urinary tract infections (UTIs) and the antimicrobial susceptibility patterns of isolated uropathogens among patients attending in Dinajpur Medical College Microbiology laboratory during January, 2023 to December, 2025. The findings revealed that 475 out of 1,944 urine samples were culture positive, resulting in an overall prevalence of 24.43%. This prevalence is comparable to reports from several developing countries where UTI remains a significant public health problem due to inadequate hygiene practices, widespread antibiotic misuse, and limited access to healthcare facilities.[12] The relatively high prevalence observed in the present study underscores the continued burden of urinary tract infections in the study population. A notable finding of this study was the higher prevalence of UTI among females compared with males. Female patients accounted for 363 (76.4%) of the 475 culture-positive cases, while males accounted for only 112 (23.6%). Similar gender distributions have been reported in previous studies conducted worldwide.[13] The increased susceptibility of women to UTI is primarily attributed to anatomical and physiological factors, including a shorter urethra, closer proximity of the urethral opening to the anal region, sexual activity, pregnancy, and hormonal influences that facilitate bacterial colonization of the urinary tract. Furthermore, recurrent infections are more frequently observed among women, contributing to the overall higher prevalence. The age-specific analysis demonstrated that the highest prevalence of infection was observed among children aged 0–10 years (56.25%) and individuals aged 51 years and above (47.4%). Increased susceptibility among children may be associated with congenital urinary tract abnormalities, poor personal hygiene, and immature immune responses. In contrast, elderly individuals often have multiple predisposing factors, including diabetes mellitus, urinary retention, prostatic enlargement, catheterization, and age-related immune decline, which increase the risk of infection.[14] The bacteriological profile revealed that *Escherichia coli* was the predominant uropathogen across most age groups. *Escherichia coli* accounted for the largest proportion of isolates, particularly among adults and elderly patients. This finding is consistent with numerous international studies that have identified *Escherichia coli* as the leading cause of both community-acquired and hospital-acquired UTIs .[15]The predominance of *Escherichia coli* can be explained by its possession of several virulence factors, including fimbrial adhesins, hemolysins, siderophores, and biofilm-forming capabilities, which enhance its ability to colonize and invade the urinary tract.[16] Other commonly isolated organisms in this study included *Enterococcus* species, *Staphylococcus* species, *Klebsiella* species, and *Pseudomonas* species, all of which are recognized uropathogens associated with complicated urinary tract infections. One of the most important findings of the present study was the high level of antimicrobial resistance observed among uropathogens. Resistance rates were particularly high against Cephradine, Cefixime, Ceftriaxone, Ceftazidime, Cefotaxime, and Moxifloxacin. Similar patterns have been reported in South Asian countries where unrestricted access to antibiotics, self-medication practices, incomplete treatment courses, and inappropriate prescribing habits have contributed to the emergence of resistant bacterial strains.[17] The widespread resistance to third-generation cephalosporins observed in this study may indicate increasing prevalence of extended-spectrum beta-lactamase (ESBL)-producing organisms within the community.

Nitrofurantoin demonstrated comparatively good activity against urinary pathogens across multiple age groups. Its sustained effectiveness may be attributed to its narrow clinical use and limited application outside urinary tract infections, thereby reducing selective pressure for resistance development. Consequently, Nitrofurantoin continues to be recommended as a first-line agent for uncomplicated UTIs in many clinical guidelines.[18] Among the tested antimicrobial agents, Imipenem showed the highest overall susceptibility, followed by Meropenem and Amikacin. These findings indicate that carbapenems remain highly effective against multidrug-resistant Gram-negative uropathogens. However, the increasing dependence on carbapenems raises concerns regarding the potential emergence of carbapenem-resistant Enterobacterales, which represent a major global health threat.[19] Therefore, carbapenem use should be reserved for severe infections and guided by culture and sensitivity results whenever possible. The increasing resistance observed against fluoroquinolones, particularly Ciprofloxacin, Levofloxacin, and Moxifloxacin, is also concerning. Fluoroquinolones have historically been used as empirical therapy for UTIs; however, rising resistance rates may significantly compromise their clinical effectiveness and lead to treatment failures.[20] This trend highlights the urgent need for antibiotic stewardship programs and evidence-based prescribing practices. Overall, the findings of this study emphasize the importance of routine urine culture and antimicrobial susceptibility testing before initiating therapy. Continuous surveillance of local resistance patterns, implementation of antimicrobial stewardship programs, and public awareness regarding rational antibiotic use are essential to combat the growing challenge of antimicrobial resistance and improve patient outcomes.

Conclusion

Urinary tract infections remain a significant public health problem, particularly among females and elderly individuals. *Escherichia coli* was the predominant causative organism. High resistance rates were observed against commonly used cephalosporins and fluoroquinolones, indicating widespread antimicrobial resistance. Imipenem, Meropenem, Amikacin, and Nitrofurantoin retained relatively good antimicrobial activity. Continuous surveillance and rational antibiotic stewardship programs are urgently needed to limit the spread of resistant uropathogens and improve treatment outcomes.

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