



Uropathogenic Bacteria and Antimicrobial Resistance Patterns in Community-Acquired UTIs: Evidence from a Regional Study in Bangladesh

Mohammad Zakerin Abedin¹, Hazrat Ali², Md. Ziaur Rahman³, Md. Shobuj Hossain⁴,
Abdullah Akthar Ahmed⁵

¹Associate Professor, Department of Microbiology, Khwaja Yunus Ali University, Sirajganj, Bangladesh; ²Lecturer, Department of Microbiology, Khwaja Yunus Ali University, Sirajganj, Bangladesh; ³Undergraduate Student (B.Sc in Microbiology), Department of Microbiology, Khwaja Yunus Ali University, Sirajganj, Bangladesh; ⁴Undergraduate Student (B.Sc in Microbiology), Department of Microbiology, Khwaja Yunus Ali University, Sirajganj, Bangladesh; ⁵Professor, Department of Microbiology, Khwaja Yunus Ali University and Khwaja Yunus Ali Medical College, Sirajganj, Bangladesh.

Abstract

Background: Urinary tract infections (UTIs) remain one of the most common bacterial infections, and their effective management is increasingly challenged by rising antimicrobial resistance (AMR), particularly in low- and middle-income countries where routine surveillance is limited. Local data on uropathogen distribution and resistance patterns are essential to guide empirical therapy. **Objective:** This study aimed to identify the bacterial etiology of community-acquired UTIs and to assess antimicrobial susceptibility patterns among patients attending a diagnostic laboratory in Pabna Sadar, Bangladesh. **Methodology:** A one year and six-month retrospective laboratory-based study was conducted, analyzing 80 consecutive, non-duplicate bacterial isolates recovered from clinically significant urine samples. Bacterial identification was performed using standard microbiological techniques, including colony morphology, Gram staining, and biochemical tests. Antimicrobial susceptibility testing was carried out using the Kirby-Bauer disk diffusion method on Mueller-Hinton agar in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines, using 16 commonly prescribed antibiotics. Data were analyzed using descriptive statistics and chi-square tests where applicable. **Results:** Of the 80 participants, 64 (80.0%) were female and 16 (20.0%) were male, with a significant difference in gender distribution ($\chi^2 = 28.8$, $df = 1$, $p < 0.001$). The mean age was 35.5 ± 21.5 years. *Acinetobacter* spp. (30%) and *Escherichia coli* (30%) were the most frequently isolated uropathogens, followed by *Enterobacter* spp. (17.5%), *Klebsiella* spp. (8.8%), *Staphylococcus* spp. (7.5%), and *Pseudomonas* spp. (6.3%). Overall susceptibility was highest to amikacin (67.5%), gentamicin (60.0%), and nitrofurantoin (60.0%). Susceptibility to levofloxacin and ciprofloxacin was 51.2% and 48.8%, respectively. The lowest susceptibility was observed for amoxicillin (10.0%), ceftazidime (21.2%), and cefotaxime (25.0%). Marked species-specific differences in susceptibility were also observed, with *Pseudomonas* spp. showing complete susceptibility to gentamicin but complete resistance to ceftriaxone and cefotaxime. **Conclusion:** The study demonstrates a high burden of antimicrobial resistance among uropathogens causing community-acquired UTIs in this regional setting. The findings highlight the need for regular local AMR surveillance and rational antibiotic prescribing to support effective empirical treatment and antimicrobial stewardship. [*Bangladesh Journal of Infectious Diseases*, June 2026;13(1):293-299]

Keywords: Urinary tract infection; Antibiotic resistance; Uropathogens; Community-acquired UTI; Antibiotic susceptibility pattern;

Correspondence: Hazrat Ali, Khwaja Yunus Ali University, Department of Microbiology, Sirajganj-6751, Bangladesh; Cell No: +8801303267014; Email: hazrat.mb@kyau.edu.bd; ORCID: <https://orcid.org/0009-0002-7472-5031>

©Authors 2026. CC-BY-NC

Introduction

Urinary tract infections represent one of the most prevalent bacterial diseases worldwide, imposing significant burdens in terms of morbidity, antimicrobial usage, and healthcare expenditure^{1,2}. They affect individuals across all age groups, but women and the elderly are disproportionately impacted due to anatomical and physiological factors³. Empirical antibiotic therapy remains the cornerstone of UTI management; nevertheless, the escalating incidence of antimicrobial resistance among uropathogens has markedly compromised the effectiveness of several first-line agents⁴.

Escherichia coli, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, and *Enterobacter* spp. are the predominant uropathogens responsible for UTIs in both community and hospital settings^{5,6}. Increasingly, these bacteria demonstrate multidrug resistance, extended-spectrum β -lactamase activity, and carbapenem resistance, thereby restricting therapeutic options. Such resistance patterns contribute to treatment failure, prolonged hospitalization, and elevated healthcare expenditures^{2,7}. Resistance patterns among uropathogens vary widely depending on geographical location, prescribing practices, and infection control measures. For this reason, continuous local surveillance is vital to provide evidence-based guidance for empirical therapy and to inform antimicrobial stewardship strategies⁴. In Bangladesh, irrational use of antibiotics, lack of strict regulatory control, and inadequate stewardship programs have contributed to a rising burden of MDR pathogens^{5,8,9}. Several institutional studies have documented this challenge. According to Bhowmick et al¹⁰, *Escherichia coli* was identified as the leading uropathogen in Jamalpur, exhibiting marked resistance to ceftriaxone and chloramphenicol while retaining susceptibility to meropenem and netilmicin¹¹. Similarly, in Tangail, *Escherichia coli* accounted for more than 80.0% of isolates, with excellent sensitivity to meropenem (98.25%) but poor susceptibility to oral agents such as cefixime, cefuroxime, and trimethoprim^{8,11-12}. Evidence from Sirajganj Sadar revealed widespread multidrug resistance among uropathogens, particularly *Escherichia coli* and *Klebsiella pneumoniae*, highlighting the critical role of regular antimicrobial susceptibility testing in guiding empirical treatment^{5,9}.

Despite these findings, information on the distribution of uropathogens and their antimicrobial resistance patterns in Pabna Sadar is limited. To address this gap, the present study aimed to identify

the bacterial etiologies of community-acquired UTIs and to evaluate their antimicrobial susceptibility profiles in a clinical laboratory setting. The findings are expected to provide locally relevant evidence to support rational antibiotic prescribing and strengthen antimicrobial stewardship initiatives in the region.

Methodology

Study Design and Setting: A retrospective, laboratory-based study was conducted over an 18-month period from July 2023 to December 2024 at the Department of Microbiology, Khwaja Yunus Ali University, Sirajganj, Bangladesh. Ethical approval was obtained from the Institutional Review Board of Khwaja Yunus Ali University (Ref.: KYAU/DEAN/SBS/2023/012). A total of 80 consecutive, non-duplicate bacterial isolates were recovered from clinically significant urine samples. The urine specimens were collected from patients attending Pacific Diagnostic Centre and Specialized Hospital, Pabna, Bangladesh. All samples were aseptically transported to the Microbiology Laboratory of Khwaja Yunus Ali University under cold-chain conditions (2 to 8°C) and processed without delay. Community-acquired urinary tract infection was defined as infection diagnosed in outpatient settings or within 48 hours of hospital admission, with no documented hospitalization in the preceding three months.

Bacterial Isolation and Identification: Urine samples were processed according to standard microbiological procedures. Specimens were cultured on appropriate media, and bacterial isolates were identified based on colony morphology, Gram staining characteristics, and conventional biochemical tests. These included catalase, oxidase, indole, citrate utilization, urease activity, and triple sugar iron (TSI) agar reactions, as appropriate for organism differentiation.

Antibiotic Susceptibility Testing (AST): Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method on Mueller-Hinton agar, in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines. The following antimicrobial agents were tested using standard disc concentrations: amikacin (30 μ g), nalidixic acid (30 μ g), nitrofurantoin (300 μ g), amoxicillin (10 μ g), cephadrine (30 μ g), ceftriaxone (30 μ g), ciprofloxacin (5 μ g), cefuroxime (30 μ g), ceftazidime (30 μ g), mecillinam (10 μ g), gentamicin (10 μ g), cefotaxime (30 μ g), levofloxacin (5 μ g), azithromycin (15 μ g), doxycycline (30 μ g), and cotrimoxazole (25 μ g).

Zone diameters were measured and interpreted as susceptible, intermediate, or resistant according to CLSI interpretive criteria.

Data Analysis: Data were entered and analyzed using R software (version 4.5.1) and RStudio (version 2025.05.1+513). Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize demographic and microbiological characteristics. Associations between categorical variables, such as bacterial species distribution and gender, were assessed using the chi-square test. A p-value of <0.05 was considered statistically significant.

Results

Demographic Characteristics: The study included 80 participants, of whom 64 were female (80.0%) and 16 male (20.0%). A statistically significant difference in gender distribution was observed ($\chi^2 = 28.8$, $df = 1$, $p < 0.001$), with females being markedly overrepresented compared to males (Figure I). This indicates that the study population was not gender-balanced (Figure I).

The mean age of participants was 35.5 ± 21.5 years (range: 1-90 years). Females ($n = 64$) had a mean age of 33.5 ± 19.0 years, whereas males ($n = 16$) averaged 43.6 ± 28.9 years. Age distribution was non normal among females (Shapiro-Wilk, $p < 0.001$) but normal among males ($p = 0.339$). Welch's two sample t test showed no significant

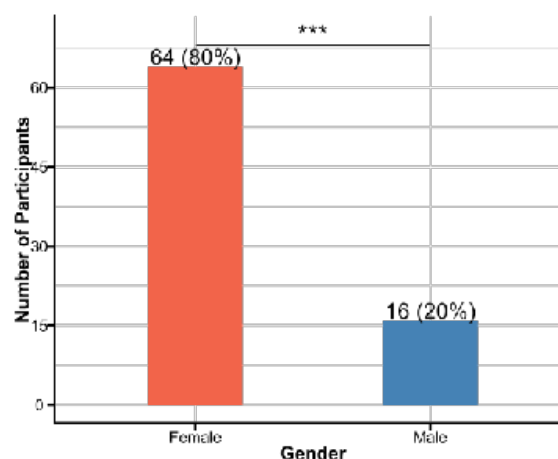


Figure I: Gender composition of study participants (N = 80). Bars represent participant counts with corresponding percentages. Statistical significance is indicated by asterisks (*) based on the Chi square goodness-of-fit test ($p < 0.001$).

difference between sexes ($t = -1.33$, $df = 18.36$, $p = 0.20$), indicating that although males tended to be older, the difference was not statistically significant (Figure II).

Distribution of Bacterial Isolates: A total of six major bacterial groups were identified among the 80 uropathogenic isolates. The most prevalent pathogens were *Acinetobacter* spp. and *E. coli*, each representing 30% ($n=24$; 95% CI: 20.5 to 41.4%) of all isolates. *Enterobacter* spp. ranked third with

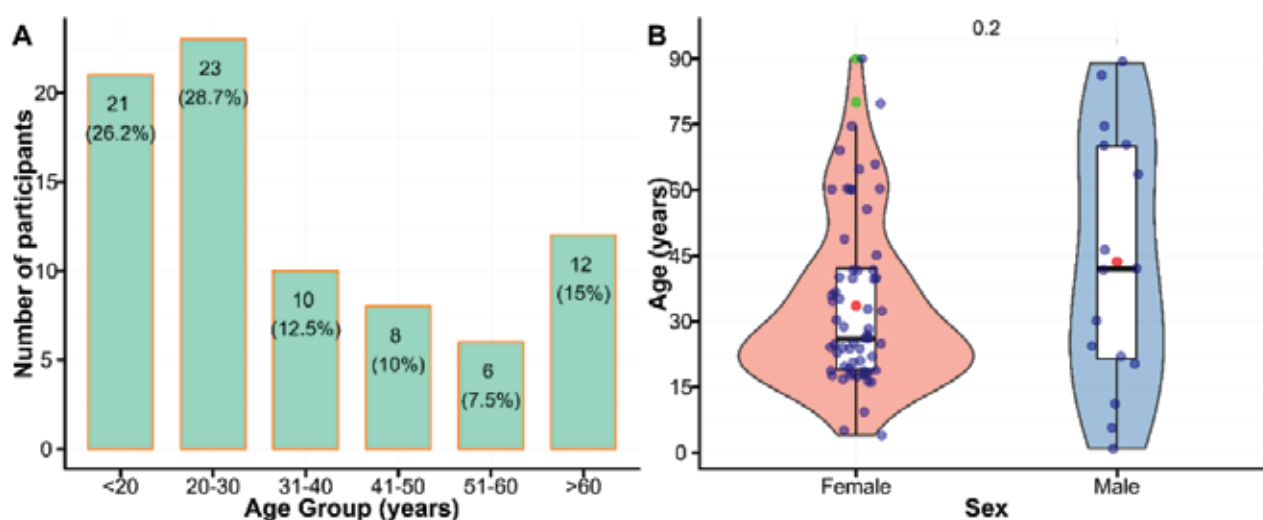


Figure II: Age profile of study participants. (A) Distribution of participants across predefined age groups. Bars represent the number of participants, and values inside the bars indicate counts with corresponding percentages. (B) Age distribution stratified by sex. Violin plots display the overall distribution, with boxplots representing medians and interquartile ranges. Individual points indicate jittered raw data. Red dots represent the mean age. Statistical comparison between sexes was performed using Welch's two-samples t-test, with significance levels indicated by p-value ($p > 0.05$).

17.5% (n=14; 95.0% CI: 10.2 to 28.0%), while *Klebsiella* spp. accounted for 8.8% (n=7; 95.0% CI: 3.9-17.7%). Less frequent isolates included *Staphylococcus* spp. (7.5%, n=6; 95.0% CI: 3.1 to 16.2%) and *Pseudomonas* spp. (6.3%, n=5; 95.0% CI: 2.3 to 14.6%). The nearly equal proportion of *Acinetobacter* spp. and *E. coli* highlights their role as the dominant uropathogens in this study population (Figure III).

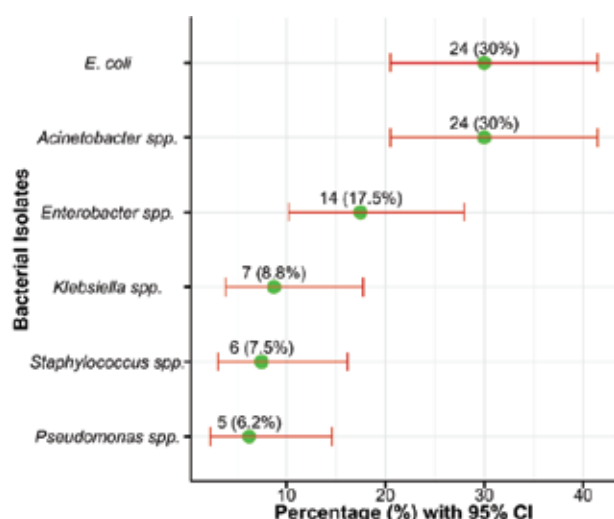


Figure III: Distribution of bacterial isolates with 95.0% confidence intervals. Forest plot shows the relative frequency of the major bacterial isolates recovered from clinical samples (N = 80). Green points represent the observed counts with percentages of each isolate, and red horizontal error bars denote the corresponding 95.0% confidence intervals (CI).

Antibiotic Response Patterns of Uropathogens:

The overall antimicrobial susceptibility profile of the uropathogenic isolates (n = 80) demonstrated substantial variability across the tested antibiotics (Figure IV). Among the aminoglycosides, amikacin exhibited the highest activity, with 67.5% of isolates classified as sensitive, while 16.2% were resistant and 16.2% showed intermediate susceptibility. Gentamicin also showed good efficacy, with 60.0% sensitivity and 32.5% resistance. Fluoroquinolones demonstrated moderate effectiveness. Levofloxacin showed 51.2% sensitivity, 38.8% resistance, and 10.0% intermediate susceptibility, whereas ciprofloxacin exhibited 48.8% sensitivity and 31.2% resistance. Nalidixic acid showed poor performance, with only 35.0% of isolates sensitive and a high resistance rate of 56.2%. Nitrofurantoin retained relatively good activity, with 60.0% of isolates sensitive, 22.5% resistant, and 17.5%

showing intermediate susceptibility. In contrast, cephalosporins were largely ineffective. Sensitivity rates were low for cefotaxime (25.0%), ceftriaxone (33.8%), ceftazidime (21.2%), cefuroxime (32.5%), and cephadrine (33.8%), with corresponding resistance rates ranging from 57.5% to 71.2%. Other antibiotics demonstrated variable activity. Mecillinam showed 40.0% sensitivity and 48.8% resistance, while cotrimoxazole exhibited 48.8% sensitivity. Doxycycline was tested against a limited number of isolates (n = 6) and showed equal proportions of sensitivity and resistance (50.0% each). Amoxicillin was the least effective antibiotic, with only 10.0% of isolates sensitive and a high resistance rate of 81.2% (Figure IV).

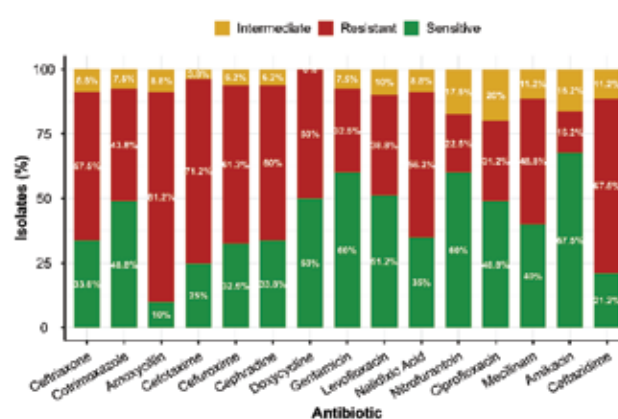


Figure IV: Antibiotic susceptibility profile of the isolated bacteria. Bar chart represents the proportions of bacterial isolates that were sensitive (green), resistant (red), or intermediate (yellow) to each tested antibiotic. Percentages within the bars represent the relative frequency of each susceptibility category.

Ranking by efficacy revealed the top 5 most effective antibiotics were amikacin (67.5%), gentamicin (60.0%), nitrofurantoin (60.0%), levofloxacin (51.2%), and ciprofloxacin (48.8%), while the bottom 5 least effective included amoxicillin (10.0%), ceftazidime (21.3%), cefotaxime (25.0%), cefuroxime (32.5%), and ceftriaxone (33.8%) (Figure V).

These results indicate that aminoglycosides and nitrofurantoin remain the most effective options, whereas beta-lactams, particularly penicillins and cephalosporins, show widespread resistance, emphasizing the importance of informed empirical therapy in urinary tract infections.

Comparative Analysis of Sensitivity Pattern with Bacterial Isolate: We performed a comparative analysis of the commonly used antibiotics with the isolated bacterial isolates, and the results showed

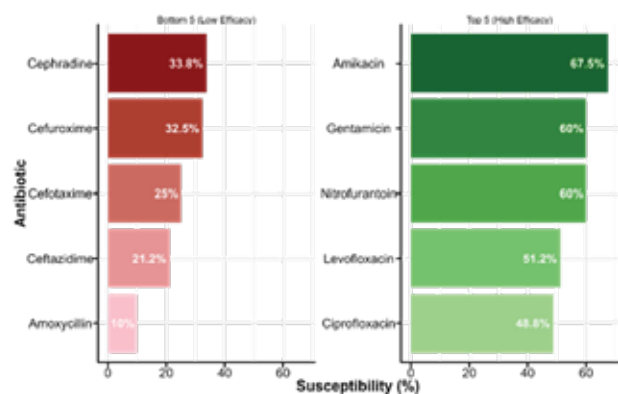


Figure V: The top 5 and bottom 5 antibiotics based on the susceptibility of bacterial isolates. Bar plots showing the antibiotics with the highest (green bars) and lowest (red bars) proportions of susceptible isolates. Bars represent the percentage of isolates susceptible to each antibiotic, with values shown inside the bars. Antibiotics are ranked in descending order of susceptibility within each group.

that *Acinetobacter* species and *Escherichia coli* were highly sensitive to Amikacin (83.3% and 62.5%, respectively), while *Pseudomonas* species exhibited complete sensitivity to Gentamicin (100.0%). *Enterobacter* species showed the highest sensitivity to Levofloxacin (71.4%), highlighting species-specific differences in fluoroquinolone activity. Conversely, *Klebsiella* species and *Staphylococcus* species displayed low sensitivity overall, particularly to gentamicin (14.3%) and levofloxacin (16.7%), respectively. Third-generation cephalosporins were largely ineffective against *Pseudomonas* species, showing complete

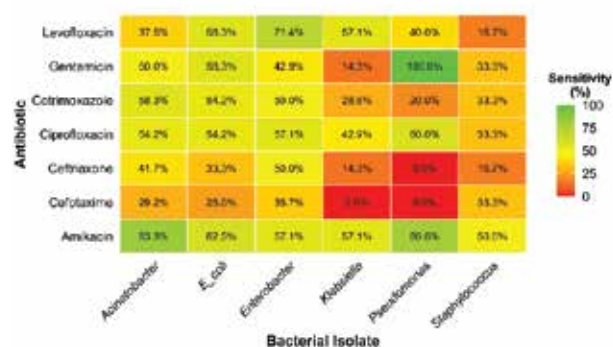


Figure VI: Comparative sensitivity profile of the top seven sensitive antibiotics to isolated bacterial genera. Heatmap shows the percentage of isolates sensitive to selected antibiotics across six bacterial genera. The color gradient ranges from red (low sensitivity) through yellow (intermediate) to green (high sensitivity). Percentages are displayed within each cell for clarity.

resistance to ceftriaxone and cefotaxime, and *Klebsiella* species were also entirely resistant to cefotaxime. Cotrimoxazole exhibited moderate activity across isolates, with sensitivity ranging from 20.0% in *Pseudomonas* species to 58.3% in *Acinetobacter* species. These results highlight marked variability in antibiotic efficacy among different uropathogens, emphasizing the need for species-specific antimicrobial selection in urinary tract infections to optimize treatment outcomes (Figure VI).

Heatmap showing the percentage of isolates sensitive to selected antibiotics across six bacterial genera. The color gradient ranges from red (low sensitivity) through yellow (intermediate) to green (high sensitivity). Percentages are displayed within each cell for clarity.

Discussion

This study evaluated the demographic distribution and antibiotic susceptibility of 80 uropathogenic isolates in a clinical setting in Pabna, Bangladesh. The age distribution revealed a predominance of young adults, with the largest groups aged 20 to 30 years (28.8%) and under 20 years (26.3%). Middle-aged (31 to 50 years) and older adults (>60 years) constituted smaller proportions, reflecting a diverse population at risk of urinary tract infections (UTIs). The mean age was 35.5 ± 21.5 years, indicating a relatively young cohort, emphasizing age-related susceptibility. This distribution reflects the higher incidence of UTIs among sexually active young individuals and the continuing susceptibility of older adults due to comorbidities and age-related immune decline^{6,7,12}.

Gender-wise analysis showed females were more frequently affected, consistent with the higher susceptibility of women to UTIs due to anatomical and hormonal factors^{1,2}. This aligns with previous reports in Bangladesh and globally, highlighting higher UTI incidence among sexually active young women^{3,12}. Studies from Bangladesh, including those by Bhowmick et al¹⁰ and Abedin et al¹¹, similarly identified *Escherichia coli* as the leading urinary pathogen in female patients across Jamalpur, Tangail, and Sirajganj. Overall, the demographic distribution emphasizes the burden of UTIs across age groups, with women and younger adults most affected, while also highlighting the vulnerability of elderly populations. These findings reinforce the need for age- and gender-specific approaches to empirical therapy and antimicrobial stewardship in Bangladesh^{4,8}. The data suggest that both preventive measures and tailored empirical therapy should

consider age-specific risk factors to optimize patient outcomes.

Acinetobacter species and *Escherichia coli* were the most frequently isolated pathogens, each comprising 30.0% of cases, followed by *Enterobacter* species (17.5%), *Klebsiella* species (8.8%), *Staphylococcus* species (7.5%), and *Pseudomonas* species (6.3%). These findings highlight the predominance of Gram-negative bacilli in UTIs, with *Escherichia coli* remaining the leading uropathogen. Although less common, other Gram-negative and Gram-positive isolates are clinically relevant due to their multidrug resistance potential. The observed distribution is consistent with previous reports from Bangladesh, where *E. coli* is persistently identified as the primary etiological agent, while the high prevalence of *Acinetobacter* species is noteworthy and suggests an increasing contribution of opportunistic and potentially nosocomial pathogens in urinary tract infections^{5,8,10}. This heterogeneous pathogen distribution highlights the importance of continuous local surveillance to inform empirical therapy.

Antimicrobial susceptibility testing demonstrated considerable variation in resistance patterns. Aminoglycosides, particularly amikacin and gentamicin, showed the highest overall activity, consistent with reports indicating preserved efficacy due to relatively restricted use. Nitrofurantoin also retained moderate effectiveness, supporting its continued role in the treatment of uncomplicated UTIs. Fluoroquinolones demonstrated only moderate sensitivity, reflecting growing resistance likely driven by widespread empirical use. In contrast, β -lactam antibiotics, including penicillins and cephalosporins, exhibited high resistance rates across multiple species. Resistance to third-generation cephalosporins was particularly pronounced, especially among *Pseudomonas* species, raising concern for extended-spectrum β -lactamase-producing organisms. Species-specific variations further emphasized the complexity of empirical treatment, with *Acinetobacter* species and *Pseudomonas* species showing higher susceptibility to amikacin, while reduced sensitivity to gentamicin, ceftriaxone, and levofloxacin was observed among *Klebsiella* species and *Staphylococcus* species.

Overall, these findings highlight the necessity of empiric therapy guided by local resistance patterns and reinforce the critical role of antimicrobial stewardship in limiting the spread of multidrug-resistant uropathogens. Aminoglycosides and nitrofurantoin may remain appropriate empiric options in this setting, whereas penicillins and

cephalosporins should be prescribed cautiously. Continued surveillance and rational antibiotic use are essential to preserve the effectiveness of existing therapies and to improve clinical outcomes in patients with urinary tract infections.

Conclusion

This study presents the demographic profile, bacterial etiology, and antimicrobial resistance patterns of uropathogens in Pabna, Bangladesh. *Acinetobacter* spp. and *Escherichia coli* were the most prevalent isolates. Aminoglycosides, particularly amikacin and gentamicin and nitrofurantoin showed the highest effectiveness, whereas penicillins and cephalosporins exhibited markedly high resistance rates. These findings caution against empirical use of beta-lactams and emphasize the importance of region-specific susceptibility data. Despite limitations including single-center design and lack of molecular analysis, the study emphasizes the urgent need for antimicrobial stewardship and rational antibiotic use to improve UTI management.

Acknowledgements

The authors gratefully acknowledge the Department of Microbiology, Khwaja Yunus Ali University, for providing laboratory facilities and technical support throughout the study. Special appreciation is extended to the hospital staff for their assistance in sample collection and to all participants for their cooperation.

Conflict of interest:

The authors affirm that there are no financial or non financial conflicts of interest associated with this work.

Financial Disclosure

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions

Conception and design: Abedin MZ, Ali H, Rahman MZ, Hossain MS; Acquisition, analysis, and interpretation of data: Abedin MZ, Ali H; Data collection: Abedin MZ, Hossain MS; Manuscript drafting and revising it critically: Abedin MZ, Hossain MS, Ahmed AA; All authors read and approved the final manuscript.

Data Availability

The datasets generated and analyzed during this study are not publicly available due to patient confidentiality and institutional data protection policies. However, anonymized data may be made available from the corresponding author upon reasonable request, subject to approval by the institutional ethics committee.

Ethics Approval and Consent to Participate

Ethical approval for the study was obtained from the Institutional Review Board. As this was a prospective study the written informed consent was obtained from all study participants. All methods were performed in accordance with the relevant guidelines and regulations.

Copyright: © Abedin et al. 2026. Published by Bangladesh Journal of Infectious Diseases. This is an open-access article

and is licensed under the Creative Commons Attribution Non-Commercial 4.0 International License (CC BY-NC 4.0). This license permits others to distribute, remix, adapt and reproduce or changes in any medium or format as long as it will give appropriate credit to the original author(s) with the proper citation of the original work as well as the source and this is used for noncommercial purposes only. To view a copy of this license, please see:

<https://www.creativecommons.org/licenses/by-nc/4.0/>

How to cite this article: Abedin MZ, Ali H, Rahman MZ, Hossain MS, Ahmed AA. Uropathogenic Bacteria and Antimicrobial Resistance Patterns in Community-Acquired UTIs: Evidence from a Regional Study in Bangladesh. *Bangladesh J Infect Dis* 2026;13(1):293-299

ORCID:

Mohammad Zakerin Abedin: <https://orcid.org/0000-0001-5639-8845>

Hazrat Ali: <https://orcid.org/0009-0002-7472-5031>

Md. Ziaur Rahman: <https://orcid.org/0009-0007-1782-0231>

Md. Shobuj Hossain: <https://orcid.org/0009-0008-7902-4836>

Abdullah Akthar Ahmed: <https://orcid.org/0000-0003-1847-9710>

Article Info

Received on: 1 June 2025

Accepted on: 12 October 2025

Published on: 1 June 2026

References

1. Foxman B. Urinary tract infection syndromes: occurrence, recurrence, bacteriology, risk factors, and disease burden. *Infectious Disease Clinics*. 2014 Mar 1;28(1):1-3
2. Flores-Mireles AL, Walker JN, Caparon M, Hultgren SJ. Urinary tract infections: epidemiology, mechanisms of infection and treatment options. *Nature reviews microbiology*. 2015 May;13(5):269-84
3. Al-Badr A, Al-Shaikh G. Recurrent urinary tract infections management in women: a review. *Sultan Qaboos University*

Medical Journal. 2013 Jun 25;13(3):359-67

4. Tacconelli E, Carrara E, Savoldi A, Harbarth S, Mendelson M, Monnet DL, et al. Discovery, research, and development of new antibiotics: the WHO priority list of antibiotic-resistant bacteria and tuberculosis. *Lancet Infect Dis*. 2018 Mar 1;18(3):318-27

5. Abedin MZ, Yeasmin F, Mia S, Helal HB, Shilpi RY. Bacteriological profile and antimicrobial susceptibility patterns of symptomatic Urinary Tract Infection among patients of different age groups in a tertiary care hospital of Bangladesh. *Moroccan J Biol*. 2020;17:59-66

6. Rowe TA, Juthani-Mehta M. Urinary tract infection in older adults. *Aging Health*. 2013 Oct 1;9(5):519-28

7. Nicolle LE. Urinary Tract Infections in the Older Adult. Vol. 32, *Clinics in Geriatric Medicine*. W.B. Saunders; 2016. p. 523-38

8. Abedin MZ, Koly FA, Aktar MdB, Islam MI, Rahaman MdA, Arfat MdE, et al. Prevalence and Antimicrobial Susceptibility Pattern of Pathogens Isolated from Different Age Groups with Urinary Tract Infection at Tangail, Bangladesh. *SSR Institute of International Journal of Life Sciences*. 2022 Jul;8(4):3044-52.

9. Abedin MZ, Arfat ME, Mia S, Das J, Koly FA, Karim MR, Farnaz NE, Afrin MN, Hasan R, Shathi JH, Sultana A. Symptomatic pathogen frequency and antibiogram patterns of bacterial isolates in urinary tract infections, Sirajganj Sadar, Bangladesh. *European Journal of Medical and Health Sciences*. 2022 Jul 11;4(4):111-21

10. Bhowmick SK, Mahtab MF, Mia S, Kuthoo MAH, Masoodi FD, Ahmed AA, Abedin MZ. Assessment of Bacterial Uropathogens and their Antibiotic Susceptibility in Rural Healthcare Facilities, Jamalpur, Bangladesh. *International Journal of Health & Medical Research* 2025 Jul 25;04(07):436-441

11. Abedinn MZ, Huda MN. Bacteremic Urinary Tract Infection and in vitro Antimicrobial Responsiveness Patterns at AMZ Hospital Ltd., Dhaka. *Khwaja Yunus Ali University Journal* 2022;5(2):1-6

12. Mia S, Masud M, Helal SB, Rahman MdS, Refat MdAR, Jarin L, et al. Isolation and Antibiotic Susceptibility of *Escherichia coli* from Urinary Tract Infections. *Asian Science Bulletin*. 2024 Jun 30;2(2):99-104.