ORIGINAL ARTICLE

Prevalence and Antimicrobial Resistance Patterns of *Escherichia coli* Causing Urinary Tract Infections: A Retrospective Study at a Tertiary Care Hospital in Karachi, Pakistan

Sadia Talib*, Syeda Hira Abid, Umber Adnan, Shomaila Malik, Tahera Kadir, Fatima Sana

ABSTRACT

Objective: To determine the prevalence and patterns of antibiotic resistance of *Escherichia coli* isolated from urinary tract infection patients.

Study Design: Retrospective cross-sectional study.

Place and Duration of Study: This study was conducted at the Department of Microbiology, Combined Military Hospital (CMH), Karachi, Pakistan, from January 2024 to December 2024.

Methods: Urine samples received from hospitalized patients with clinical features of urinary tract infection were processed using standard microbiological techniques. Isolates were identified as *Escherichia coli* by conventional biochemical methods. The Kirby-Bauer disk diffusion method was used to test for antimicrobial susceptibility in compliance with Clinical and Laboratory Standards Institute (CLSI) M100, 33rd Edition, 2023 guidelines. The combined disk diffusion method was used to detect the production of extended-spectrum beta-lactamase. Demographic and clinical data were analyzed using statistical software 25, and associations were assessed using appropriate statistical tests.

Results: A total of 453 non-duplicate *Escherichia coli* isolates were recovered from urine samples. Female patients accounted for 60% of cases, while male patients accounted for 40%. The highest frequency of infection among females was observed in the 20–40-year age group, whereas infections in males were more common in older age groups. Resistance was universal to amoxicillin and markedly high to beta-lactam and beta-lactamase inhibitor combinations, cephalosporins, fluoroquinolones, aminoglycosides, and trimethoprim-sulfamethoxazole. Nitrofurantoin and carbapenems showed comparatively lower rates of resistance. Extended-spectrum beta-lactamase–producing isolates constituted a substantial proportion of cases, indicating limited therapeutic options.

Conclusion: The research shows that urinary *Escherichia coli* isolates from a tertiary care hospital setting exhibit a high level of antibiotic resistance. The predominance of extended-spectrum beta-lactamase–producing strains highlights the urgent need for rational antibiotic prescribing, routine culture-based therapy, and strengthened antimicrobial stewardship programs.

Keywords: *Antimicrobial Resistance, Escherichia, Coli, Pakistan, Urinary Tract Infections.*

How to cite this: *Talib S, Abid SH, Adnan U, Malik S, Kadir T, Sana F. Prevalence and Antimicrobial Resistance Patterns of Escherichia coli Causing Urinary Tract Infections: A Retrospective Study at a Tertiary Care Hospital in Karachi, Pakistan. Life and Science. 2026; 7(3): 285-290. doi: http://doi.org/10.37185/LnS.1.1.1066*

Introduction

Urinary tract infections (UTIs) continue to be among the most frequently encountered bacterial infections in both community and hospital settings, leading to recurrent morbidity, increased healthcare costs, and risk of complications such as pyelonephritis and sepsis. Uropathogenic *Escherichia coli* (UPEC) are the principal etiological agents, often accounting for 70–90% of uncomplicated UTIs and a similarly high proportion of complicated cases.[1,2] In recent years, the epidemiology of UTIs has been complicated by the

Department of Pathology
Karachi Institute of Medical Sciences (KIMS), Karachi, Pakistan
Correspondence:
Dr. Sadia Talib
Assistant Professor, Pathology
Karachi Institute of Medical Sciences (KIMS), Karachi, Pakistan
E-mail: sadiakashif123@yahoo.com

Received: Nov 11, 2025; 1st Revision Received: Feb 22, 2026
2nd Revision Received: May 10, 2026; Accepted: May 15, 2026

escalating burden of antimicrobial resistance (AMR), with the rise in the prevalence of *E. coli* that produces extended-spectrum β-lactamase (ESBL) and multidrug-resistant (MDR).[3-4]

AMR has been recognized by the World Health Organization (WHO) as one of the main risks to world health, forecasting that without effective interventions, antimicrobial-resistant infections could result in millions of deaths annually.[5] In the context of UTIs, the spread of MDR *E. coli* substantially narrows empiric treatment options and leads to higher rates of therapeutic failure, hospital stay prolongation, and mortality.

In South Asia, including Pakistan, several recent studies have documented alarming resistance trends in uropathogens. For instance, Khan A et al. reported a high frequency of MDR *E. coli* harboring virulence and efflux genes among women with uncomplicated UTIs in Pakistan.[6] Another large-scale surveillance from Pakistan and India indicated MDR rates of 43 % and 59 %, respectively, with a further rise to ~66 % in some settings.[7] In Pakistan specifically, mapping of antimicrobial susceptibility in UTI isolates demonstrated widespread resistance patterns among *E. coli*, including to first-line agents.[8]

Globally, meta-analyses and surveillance studies reflect an elevated incidence of ESBL-producing *E. coli*. A recent global mapping study estimated the annual incidence of MDR and ESBL-producing *E. coli* at 12.38 and 12.95 per 1,000 population, respectively, in Africa alone.[9] In another meta-analysis, the pooled prevalence of human intestinal carriage of ESBL *E. coli* was 21.1 %, indicating substantial community reservoirs.[10] Surveillance in Thailand and elsewhere has documented that roughly 42–45 % of clinical *E. coli* isolates are ESBL-producers, frequently with co-resistance to fluoroquinolones and trimethoprim-sulfamethoxazole.[11] In Pakistan, investigations of urinary *E. coli* isolates have confirmed high rates of ESBL production and multidrug resistance, with concomitant resistance to cephalosporins, fluoroquinolones, and aminoglycosides.[12]

The emergence of extensively drug-resistant (XDR) *E. coli* (resistant to all but one or two antibiotic classes) is a further clinical threat, forcing reliance on carbapenems or last-resort agents.[13] However, reports of carbapenem-nonsusceptible *E. coli* have started to emerge. A recent genomic surveillance study from the Indian subcontinent disclosed isolates co-harboring bla_NDM and mcr-1, signaling resistance to both carbapenems and colistin.[7] The trend toward reduced carbapenem susceptibility in UTI pathogens poses a grave challenge to therapy and underscores the urgency of antimicrobial stewardship.

Moreover, the mechanisms underpinning MDR and ESBL emergence in *E. coli* are well studied: Resistance genes can spread horizontally via mobile genetic elements, including integrons, plasmids, and transposons; efflux pumps, porin loss, and enzymatic degradation further compound resistance phenotypes.[14] Given the convergence of high resistance, constrained treatment options, and potential for dissemination across hospital and community settings, ongoing surveillance and phenotypic and genotypic characterization are critical.

This study aimed to determine the prevalence and resistance patterns of *E. coli* isolates from UTI patients in a tertiary care hospital in Pakistan and to highlight the clinical implications of increasing resistance in routine practice.

Methods

This retrospective cross-sectional study was carried out at the Department of Microbiology, Combined Military Hospital (CMH), Karachi, Pakistan, from January 2024 to December 2024, after taking approval from the Institutional Review Board of the hospital, vide letter no: 133/2023/Trg/ERC, dated: 11th August 2023. There were 453 urine samples that yielded pure *Escherichia coli* growth, collected from patients admitted to gynecology, surgery, medicine, urology, and nephrology wards. Consecutive non-probability sampling was employed. Patients of all ages with symptomatic urinary tract infections (UTIs), including both catheterized and non-catheterized individuals, were eligible, while those with mixed growth, contaminated samples, or prior antibiotic therapy within 72 hours before sample collection were excluded. All urine samples were cultured on cysteine lactose electrolyte-deficient (CLED) agar, and isolates were identified as *E. coli* using standard biochemical methods, including indole positivity, lactose fermentation, motility positivity, citrate negativity, urease negativity, and

Table 1: Patient distribution by ward (N= 453)

Ward	Number of Patients (%)
Gynaecology	121 (27)
Surgery	55 (12)
Medicine	84 (18)
Nephrology	77 (17)
Urology	116 (26)

Table 2: Prevalence of urinary tract infection in different age groups of females and males (N=453)

Age Group (Years)	Number of Females (%) N = 271 (60%)	Number of Males (%) N = 182 (40%)
20–30	69 (25)	30 (17)
31–40	69 (25)	12 (7)
41–50	15 (6)	42 (23)
51–60	15 (6)	19 (10)
61–70	60 (22)	42 (23)
>70	43 (16)	37 (20)

Table 3: Prevalence of Catheter-Associated UTI (N=453)

Patients	Catheter-Associated UTI N (%)	Non-Catheter-Associated UTI N (%)	Total (%)
Females	82 (55)	189 (62)	271 (60)
Males	67 (45)	115 (38)	182 (40)
Total	149 (33)	304 (67)	453 (100)

UTI = urinary tract infection association between gender and catheter-associated UTI was not significant, as the P-value> 0.05. Chi-Square test (X^2 = 2.12, df = 1, P = 0.145)

characteristic reactions on Triple Sugar Iron (TSI) agar. The Kirby-Bauer disk diffusion technique was used to perform antimicrobial susceptibility testing (AST), and the Clinical and Laboratory Standards Institute (CLSI) 2023 criteria were followed for interpretation.

Antibiotics tested included first-line agents (amoxicillin, augmentin, cefixime, cefotaxime, ceftriaxone, ciprofloxacin, levofloxacin, cotrimoxazole, nitrofurantoin) and second-line agents (cefepime, meropenem, imipenem, piperacillin/tazobactam, gentamicin, amikacin). Phenotypic detection of extended-spectrum β-lactamase (ESBL) production was carried out using the combined disk diffusion method with cefotaxime and cefotaxime–clavulanate discs, following CLSI recommendations.[15] SPSS version 25 was used to analyze the data, and descriptive statistics were presented as percentages and frequencies. The relationship between gender and catheter-associated UTIs was examined using the Chi-Square test; a *P*-value of less than 0.05 was deemed statistically significant.

Results

Culture of 453 urinary samples yielded growth of *E. coli*. These samples were received from various wards, including gynaecology 27%, urology 26%, medicine 19%, nephrology 17%, and surgery 12% (Table 1).

Among participants of the study, 60% were females, while 40% were males. Among females, fifty percent of the participants (50%) were between the ages of 20 and 40, whereas 23% of the male participants were between the ages of 41 to 50 and 61 to 70 years (Table 2).

Catheter-associated UTI was observed in 149 patients, among them 82 were females and 67 were males; however, 304 patients had no catheter-associated UTI, including 189 females and 115 males. There was no significant association (X^2 = 2.12, df = 1, *P* = 0.145) between gender and catheter-associated UTI, as the P-value was greater than 0.05 (Table 3).

Culture and sensitivity testing was performed on *E. coli* isolates, and the highest resistance was observed to amoxicillin (100%), followed by augmentin (75%). About 74 % of isolates were resistant against

Table 4: Antibiotic Susceptibility Pattern of E.coli Isolates (N=453)

Antibiotics	Resistant N (%)
First Line of Antibiotics	
Amoxycillin	453 (100)
Cefixime	333 (74)
Cefotaxime	333 (74)
Ceftriaxone	333 (74)
Ciprofloxacin	295 (65)
Cotrimoxazole	232 (52)
Levofloxacin	275 (61)
Nitrofurantoin	98 (22)
Second Line of Antibiotics	
Cefepime	333 (74)
Meropenem	116 (26)
Piperacillin/Tazobactam	310 (68)
Gentamycin	259 (57)
Imipenem	123 (27)
Augmentin	340 (75)
Amikacin	251 (55)
ESBL	326 (72)
XDR	127 (28)

ESBL = Extended-spectrum beta-lactamases, XDR = Extensive drug resistance

cephalosporins like cefixime, cefotaxime, ceftriaxone, and cefepime. Resistance against other antimicrobials was piperacillin/tazobactam 68%, ciprofloxacin 65%, levofloxacin 61%, gentamicin 57%, amikacin 55%, cotrimoxazole 52%, imipenem 27%, meropenem 26%, and nitrofurantoin 22%. ESBL-producing isolates were 72%; however, XDR isolates were 28% (Table 4). Multidrug-resistant (MDR) isolates were defined as isolates non-susceptible to at least one agent in three or more antimicrobial categories. Extensively drug-resistant (XDR) isolates were defined as isolates non-susceptible to at least one agent in all but two or fewer antimicrobial categories.

Discussion

This study indicates that among UTI patients in a Pakistani tertiary care hospital, multidrug-resistant (XDR) and extended-spectrum β-lactamase (ESBL)-producing *Escherichia coli* isolates are more prevalent.

A significant finding was the universal resistance to amoxicillin and the high rates of resistance to β-lactam/β-lactamase inhibitor combinations and cephalosporins. These results are consistent with recent reports from South Asia and other low- and middle-income countries documenting similar resistance profiles.[14] Similar resistance patterns have been documented in Pakistan, South Asia, and global surveillance studies, emphasizing the clinical relevance of these findings.[16-20]

Fluoroquinolone and aminoglycoside resistance rates exceeding 50% further limit available treatment options, corroborating findings from previous studies in Pakistan and regional surveillance networks.[17,18] The high prevalence of ESBL-producing isolates (72%) in this study is particularly concerning, as it exceeds the global average of 25–50% reported in multicountry analyses.[20]

The ESBL prevalence of 72% observed in the present study is higher than that reported in Thailand and several international studies, suggesting substantial local antimicrobial selection pressure and dissemination of resistant clones.[21]

Imipenem and meropenem, two carbapenems, remained effective against most isolates, although resistance was observed in approximately one-fourth of strains. This trend of carbapenem resistance parallels recent findings from India and other South Asian countries.[21] Nitrofurantoin showed the highest efficacy among first-line agents, confirming its continued role as a preferred oral

option for uncomplicated UTIs.[22-24] Nitrofurantoin demonstrated the lowest rate of resistance and remains a useful oral option for uncomplicated urinary tract infections.[25]

The prevalence of ESBL-producing *E. coli* (72%) observed in the present study is considerably higher than rates reported in Europe and North America, but with reports from South Asia, 71 (32.1%) *E.coli* isolates were phenotypically confirmed as ESBL producers. [26]

Carbapenem resistance observed in the present study is consistent with reports from Pakistan showing the increasing emergence of carbapenem-resistant Enterobacterales. Recent surveillance studies have identified the dissemination of blaNDM and other carbapenemase genes among urinary *E. coli* isolates, raising concerns about the preservation of carbapenem efficacy.[27]

The high prevalence observed for ESBL may reflect the tertiary-care setting of the study, where patients often have prolonged hospital stays, prior antibiotic exposure, recurrent infections, and multiple comorbidities.

The retrospective, single-center design of this study is a limitation, as molecular typing and analyses of host-related risk factors were not performed. Future multicenter studies incorporating genomic surveillance and molecular epidemiology are required to track the dissemination of resistance determinants. However, these results highlight the urgency with which antimicrobial stewardship initiatives are needed, routine culture and susceptibility testing, and strict infection control policies to mitigate an increasing number of *E. Coli* that produce ESBLs and MDR in both community and hospital settings

Conclusion

Urinary *Escherichia coli* isolates demonstrated high resistance to commonly prescribed antibiotics, including cephalosporins, fluoroquinolones, and aminoglycosides. The high prevalence of ESBL-producing and XDR strains significantly limits therapeutic options. Nitrofurantoin and carbapenems retained comparatively better activity and may remain useful treatment options. Continuous surveillance, antimicrobial stewardship programs, and culture-guided therapy are essential to control the growing burden of antimicrobial resistance in Pakistan.

Acknowledgment: None

Conflict of Interest: The authors declare no conflict of interest

Grant Support and Financial Disclosure: None

REFERENCES

1. Whelan S, O'Grady MC, Corcoran D, Finn K, Lucey B. Uropathogenic Escherichia coli (UPEC)-associated urinary tract infections: the molecular basis for challenges to effective treatment. Microorganisms. 2023; 11: 2169. doi: 10.3390/microorganisms110202169
2. Fatima S, Akbar A, Irfan M, Shafee M, Ali A, Ishaq Z, et al. Virulence factors and antimicrobial resistance of uropathogenic Escherichia coli EQ101 UPEC isolated from UTI patient in Quetta, Balochistan, Pakistan. BioMed research international. 2023; 2023: 7278070. doi: 10.1155/2023/7278070
3. Halldórsdóttir AM, Hrafnkelsson B, Einarsdóttir K, Kristinsson KG. Prevalence and risk factors of extended-spectrum beta-lactamase producing E. coli causing urinary tract infections in Iceland during 2012–2021. European Journal of Clinical Microbiology & Infectious Diseases. 2024; 43: 1689-97. doi: 10.1007/s10096-024-04882-z
4. Mir SS, Ali E, Alghamdi SA, Alghamdi NM, Alharbi RA, Sindi AA, et al. Antimicrobial Resistance in Urinary Tract Infections Among Patients with and Without Renal Comorbidities: A Retrospective Study from Al-Baha, Saudi Arabia. Pathogens. 2025; 14: 1297. doi: 10.3390/pathogens14121297
5. Asmare Z, Erkihun M, Abebe W, Tamrat E. Antimicrobial resistance and ESBL production in uropathogenic Escherichia coli: a systematic review and meta-analysis in Ethiopia. JAC-antimicrobial resistance. 2024; 6: dlae068. doi: 10.1093/jacamr/dlae068
6. Khan A, Saraf VS, Siddiqui F, Batool T, Noreen Z, Javed S, et al. Multidrug resistance among uropathogenic clonal group A E. Coli isolates from Pakistani women with uncomplicated urinary tract infections. BMC microbiology. 2024; 24: 74. doi: 10.1186/s12866-024-03221-8
7. Sivarajan V, Ganesh AV, Subramani P, Ganesapandi P, Sivanandan RN, Prakash S, et al. Prevalence and genomic insights of carbapenem resistant and ESBL producing Multidrug resistant Escherichia coli in urinary tract infections. Scientific Reports. 2025; 15: 2541. doi: 10.1038/s41598-024-84754-w
8. Ashraf Z, Rasool MH, Aslam B, Ejaz H, Mujahid F, Khurshid M. Dynamics of urinary tract infections: a comprehensive study on antimicrobial susceptibility, virulence profiling and molecular epidemiology of uropathogenic Escherichia coli from Pakistan. Molecular Biology Reports. 2025; 52: 694. doi: 10.1007/s11033-025-10799-3
9. Ng RW, Yang L, Lau SH, Hawkey P, Ip M. Global prevalence of human intestinal carriage of ESBL-producing E. coli during and after the COVID-19 pandemic. JAC-Antimicrobial Resistance. 2025; 7: dlaf001. doi: 10.1093/jacamr/dlaf001
10. Bush K, Bradford PA. Epidemiology of β-lactamase-

producing pathogens. Clinical microbiology reviews. 2020; 33: 10-128. doi: 10.1128/CMR.00047-19
11. Siriphap A, Kitti T, Khuekankaew A, Boonlao C, Thephinlap C, Thepmalee C, et al. High prevalence of extended-spectrum beta-lactamase-producing Escherichia coli and Klebsiella pneumoniae isolates: A 5-year retrospective study at a Tertiary Hospital in Northern Thailand. Frontiers in Cellular and Infection Microbiology. 2022; 12: 955774. doi: 10.3389/fcimb.2022.955774
12. Mahshouri P, Alikhani MY, Momtaz HE, Doosti-Irani A, Shokoohizadeh L. Analysis of phylogroups, biofilm formation, virulence factors, antibiotic resistance and molecular typing of uropathogenic Escherichia coli strains isolated from patients with recurrent and non-recurrent urinary tract infections. BMC Infectious Diseases. 2025; 25: 267. doi: 10.1186/s12879-025-10635-w
13. Rozwadowski M, Moszynska M, Krawczyk B. Molecular Factors and Mechanisms Driving Multidrug Resistance in Uropathogenic E. coli. Genes (Basel). 2022; 13: 1397. doi: 10.3390/genes13081397
14. Parajuli NP, Maharjan P, Parajuli H, Joshi G, Paudel D, Sayami S, et al. High rates of multidrug resistance among uropathogenic Escherichia coli in children and analyses of ESBL producers from Nepal. Antimicrobial Resistance & Infection Control. 2017; 6: 9. doi: 10.1186/s13756-016-0168-6
15. Wayne PA. Clinical and laboratory standards institute. Performance standards for antimicrobial susceptibility testing. 2011; 31: 100-121. Available at: https://www.sid.ir/paper/655659/en
16. Magiorakos AP, Srinivasan A, Carey RB, Carmeli Y, Falagas ME, Giske CG, et al. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. Clinical microbiology and infection. 2012; 18: 268-81. doi: 10.1111/j.1469-0691.2011.03570.x
17. Riaz M, Jadoon S, Khalid H, Khan A, Khan T, Mehnaz G, et al. The abundance of ESBL-expressing, multidrug-resistant Escherichia coli in Pakistani patients with urinary tract infections. Chinese Journal of Otorhinolaryngology Head and Neck. 2024; 55: 1347-56.
18. Bullens M, de Cerqueira Melo A, Raziq S, Lee J, Khalid GG, Khan SN, et al. Antibiotic resistance in patients with urinary tract infections in Pakistan. Public Health Action. 2022; 12: 48-52. doi: 10.5588/pha.21.0071
19. Tesfaye NA, Demessie MB, Hassen M, Solomon T, Andualem A, Gebreegziabher TL, et al. E. coli as a uropathogen in patients with diabetes mellitus, its prevalence and antimicrobial resistance profile in Ethiopia: A systematic review and meta-analysis. BMC Infectious Diseases. 2025; 25: 1276. doi: 10.1186/s12879-025-11714-8
20. World Health Organization. Global Antimicrobial Resistance and Use Surveillance System (GLASS) Report 2022. Geneva: WHO; 2022. Available from: https://www.who.int/publications/i/item/9789240062702
21. Gupta E, Mohanty S, Sood S, Dhawan B, Das BK, Kapil A. Emerging resistance to carbapenems in a tertiary care hospital in north India. Indian Journal of Medical Research. 2006; 124: 95-8.
22. Saechue B, Atwill ER, Jeamsripong S. Occurrence and molecular characteristics of antimicrobial resistance, virulence factors, and extended-spectrum β-lactamase (ESBL) producing Salmonella enterica and Escherichia coli isolated from the retail produce commodities in Bangkok, Thailand. Heliyon. 2024; 10: e26811. doi: 10.1016/j.heliyon.2024.e26811
23. Huang L, Huang C, Yan Y, Sun L, Li H. Urinary tract infection etiological profiles and antibiotic resistance patterns varied among different age categories: a retrospective study from a tertiary general hospital during a 12-year period. Frontiers in microbiology. 2022; 12: 813145. doi: 10.3389/fmicb.2021.813145
24. Bunduki GK, Heinz E, Phiri VS, Noah P, Feasey N, Musaya J. Virulence factors and antimicrobial resistance of uropathogenic Escherichia coli (UPEC) isolated from urinary tract infections: a systematic review and meta-analysis. BMC infectious diseases. 2021; 21: 753. doi: 10.1186/s12879-021-06435-7
25. Biswas S, Rana R, Bal M, Pati S, Suar M, Ranjit M. Escherichia coli associated urinary tract infection: Epidemiology and possible strategies for control. One Health Bulletin. 2025; 5: 51-7. doi: 10.4103/ohbl.ohbl_56_24
26. Kumar A, Islam A, Singh AK, Yadav SK. Prevalence of Esbl-Producing E. Coli in Outpatient Urinary Tract Infections. International Journal of Pharmacy Research & Technology. 2026; 16: 766-77.
27. Khawaja T. Pathways to antimicrobial resistance: antibiotic use and bacterial colonisation in low-and middle-income settings. 2026. Available at: https://helda.helsinki.fi/server/api/core/bitstreams/965e2ad5-186c-4ea0-a1db-afaa2fe9159a/content

Author Contributions

ST: Conception, design of the work, and approval for final submission
SHA: Data acquisition, curation, statistical analysis, and approval for final submission
UA: Manuscript writing for methodology design, investigation, and approval for final submission
SM: Validation of data, interpretation, write-up of results, and approval for final submission
TK: Revising, editing, supervising for intellectual content, and approval for final submission
FS: Writing the original draft, proofreading, and approval for final submission
ST is the nominated guarantor and takes full responsibility for the overall content and integrity of the work