INSIGHTS-JOURNAL OF
LIFE AND SOCIAL SCIENCES

INSIGHTS-JLSS
Insights-Journal of Life and Social Sciences

PREVALENCE OF ANTIBIOTIC RESISTANCE IN PEDIATRIC URINARY TRACT INFECTION CASES: A CROSS-SECTIONAL STUDY

Original Article

Saleem Asghar Shar Baloch[1]*, Aqib Ashraf[2], Shaista Hamid[3], Rabia Azam[4], Tehreem Abbas[4], Sidra Rafique[5], Malghalara Masood[6]
[1]Faculty of Pharmacy, University of Sindh, Jamshoro, Pakistan.
[2]Medical Officer, Department of Pediatric Medicine, Pak Red Crescent Hospital and Medical College Dina Nath, Phool Nagar, Pakistan.
[3]Associate Professor, Jinnah University for Women, Karachi, Pakistan.
[4]House Officer, Pak Red Crescent Teaching Hospital, Lahore, Pakistan.
[5]General Practitioner, Paspida Liver Centre, Lahore, Pakistan.
[6]MBBS Student, Bolan Medical College, Quetta, Pakistan.
Corresponding Author: Saleem Asghar Shar Baloch, Faculty of Pharmacy, University of Sindh, Jamshoro, Pakistan, sharsalim@gmail.com
Conflict of Interest: None | Grant Support & Financial Support: None
Acknowledgment: The authors thank the clinical staff for their support during data collection.

ABSTRACT

Background: Pediatric urinary tract infections (UTIs) are a common clinical concern, with increasing resistance to empirical antibiotics posing a major challenge to effective management. Local resistance surveillance is essential for guiding appropriate treatment strategies.

Objective: To assess the frequency and resistance patterns of uropathogens isolated from pediatric UTI cases in a tertiary care hospital in Lahore.

Methods: A cross-sectional study was conducted over eight months, enrolling 422 children aged 1 month to 12 years with culture-confirmed UTIs. Urine samples were processed using standard microbiological techniques. Antibiotic susceptibility testing was performed using the Kirby-Bauer disk diffusion method according to CLSI guidelines. Data were analyzed using SPSS v26, with statistical significance set at $p<0.05$.

Results: *Escherichia coli* was the most prevalent uropathogen (69.2%), followed by *Klebsiella pneumoniae* (13.7%) and *Proteus mirabilis* (5.7%). High resistance rates were observed in *E. coli* to ampicillin (84.6%), co-trimoxazole (65.1%), and cefixime (52.3%). Nitrofurantoin (13.4%) and meropenem (3.4%) showed the lowest resistance. Multidrug resistance was identified in 53.4% of *E. coli* and 65.5% of *Klebsiella* isolates. The findings reveal a concerning trend of diminished efficacy of first-line antibiotics in pediatric UTIs.

Conclusion: The high prevalence of resistant and multidrug-resistant uropathogens necessitates routine local antibiogram development to inform empirical therapy in pediatric UTIs. Optimized antimicrobial stewardship and updated treatment guidelines are critical for preserving antibiotic efficacy in this vulnerable population.

Keywords: Anti-Bacterial Agents, Child, Drug Resistance, Escherichia coli, Multidrug Resistance, Pediatric Infections, Urinary Tract Infections.

INTRODUCTION

Urinary tract infections (UTIs) are among the most common bacterial infections in children, representing a significant cause of morbidity and frequent healthcare visits in pediatric populations. These infections can occur at any age, though they are particularly prevalent among infants and young children, where they often present with non-specific symptoms that complicate timely diagnosis. Prompt and appropriate treatment is essential to prevent complications such as renal scarring, hypertension, and, in severe cases, chronic kidney disease (1). However, the increasing prevalence of antibiotic-resistant uropathogens has emerged as a critical threat to the effective management of pediatric UTIs, posing significant challenges for clinicians and health systems alike. The rise of antimicrobial resistance (AMR) is a pressing global health issue, and pediatric populations are uniquely vulnerable (2). Unlike adults, children often have limited therapeutic options due to age-related safety profiles of certain drugs and differences in pharmacokinetics and pharmacodynamics. Moreover, empirical treatment—the common initial approach in pediatric UTI cases—is becoming increasingly unreliable as resistance patterns shift (3). Escherichia coli remains the most frequently isolated uropathogen in children, yet studies from various regions have documented rising resistance rates to commonly prescribed antibiotics, including ampicillin, co-trimoxazole, and even some third-generation cephalosporins. This changing resistance landscape makes it essential to continually monitor local susceptibility trends to inform clinical guidelines and optimize treatment strategies (4,5).

Antibiotic overuse and misuse play pivotal roles in accelerating the development of resistant bacterial strains. In many healthcare settings, including pediatric units, antibiotics are often prescribed empirically without culture confirmation, contributing to unnecessary exposure and selection pressure. Furthermore, resistance can vary significantly across geographic areas, institutions, and patient demographics, making localized data indispensable (6). For example, studies conducted in different parts of the world, from urban hospitals in high-income countries to resource-constrained settings in low- and middle-income nations, have reported stark differences in both the prevalence and type of resistance (7,8). These findings underscore the importance of region-specific surveillance to guide empirical therapy. Despite a growing body of literature on AMR in adult UTIs, pediatric populations remain underrepresented in many studies, particularly in low-resource healthcare systems. This research gap is concerning given that the burden of disease and the consequences of ineffective treatment may be even more profound in children (9). Young patients often present with atypical symptoms, are more likely to experience recurrent infections, and may suffer more lasting damage from improperly treated UTIs. Moreover, they may be exposed to a different spectrum of antibiotics and have distinct patterns of hospital exposure, all of which influence resistance development (10).

In clinical practice, early identification of resistant pathogens can facilitate more targeted therapy, reduce unnecessary hospital stays, and limit complications. However, without up-to-date local data, healthcare providers may be left to rely on outdated guidelines or generalized resistance patterns that do not accurately reflect their patient population. This situation highlights the need for focused research that bridges this informational gap and supports data-driven decision-making in pediatric infectious disease management (11,12). Given the global threat posed by antibiotic resistance and its profound implications for child health, there is a pressing need for studies that characterize the prevalence and patterns of resistance among pediatric UTI pathogens within specific clinical contexts. Such research not only informs effective treatment protocols but also supports broader public health initiatives aimed at stewardship and resistance mitigation. This study was undertaken to assess the frequency and patterns of antibiotic-resistant uropathogens isolated from children diagnosed with urinary tract infections in a hospital setting. By providing localized, evidence-based insights, it aims to support more informed clinical decisions and contribute to the ongoing efforts to curb antimicrobial resistance in pediatric care.

METHODS

This cross-sectional study was conducted over a period of eight months at the pediatric department of a tertiary care hospital in Lahore, Pakistan, with the objective of assessing the frequency and resistance patterns of antibiotic-resistant uropathogens isolated from children diagnosed with urinary tract infections (UTIs). The study was designed to gather comprehensive, locally relevant microbiological data that could guide empirical treatment and enhance antibiotic stewardship in pediatric care. Children aged 1 month to 12 years who were admitted to or presented at the pediatric outpatient department with a clinical diagnosis of UTI were considered for inclusion in the study. Diagnosis was based on clinical symptoms such as fever, dysuria, frequency, suprapubic pain, flank pain, vomiting, or irritability in younger children, and confirmed by a positive urine culture indicating significant bacteriuria ($\geq 10^5$ colony-forming units/mL of a single uropathogen). Exclusion criteria included children with known anatomical abnormalities of the urinary tract, prior urological surgeries, ongoing antibiotic therapy within the past 48 hours, or known immunodeficiency disorders, to minimize potential confounding factors and ensure the accuracy of microbial resistance profiling (12,13).

Using a single population proportion formula and assuming a 50% expected prevalence of antibiotic resistance (to maximize sample size), a 95% confidence level, and a 5% margin of error, the minimum sample size calculated was 384 children. Accounting for a 10% potential dropout or contamination rate, a final sample size of 422 was targeted. Each child meeting the inclusion criteria was enrolled consecutively using a non-probability consecutive sampling technique until the sample size was achieved. Clean-catch midstream urine samples were collected in sterile containers from toilet-trained children, while urine was obtained using catheterization or urine collection bags for infants and younger children who could not provide a clean sample. All specimens were transported promptly to the hospital's microbiology laboratory under proper conditions to maintain sample integrity. Urine samples were processed within two hours of collection using standard culture methods on CLED (Cystine Lactose Electrolyte Deficient) agar and MacConkey agar media. Isolated organisms were identified using conventional biochemical tests and, where required, automated identification systems.

Antibiotic susceptibility testing was conducted using the Kirby-Bauer disk diffusion method in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines. A panel of commonly prescribed antibiotics in pediatric UTI cases—such as ampicillin, co-trimoxazole, nitrofurantoin, cefixime, ceftriaxone, gentamicin, ciprofloxacin, and meropenem—was selected for sensitivity profiling. Zones of inhibition were measured and interpreted using standard CLSI breakpoints to determine resistance or susceptibility. Multidrug resistance (MDR) was defined as non-susceptibility to at least one agent in three or more antimicrobial categories (14,15). All data collected, including demographic variables (age, gender), clinical symptoms, isolated uropathogens, and resistance patterns, were recorded in a predesigned data collection form. Data were then entered and analyzed using SPSS version 26.0. Descriptive statistics were used to present frequencies and percentages for categorical variables, while means and standard deviations were calculated for continuous variables. Chi-square tests were applied to determine associations between resistance patterns and demographic or clinical variables, with a p-value <0.05 considered statistically significant. The normal distribution of data was confirmed using the Kolmogorov-Smirnov test before proceeding with parametric statistical tests.

Ethical approval for the study was obtained from the Institutional Review Board of the hospital (IRB). Written informed consent was taken from the parents or legal guardians of all enrolled children after providing a clear explanation of the study's purpose, procedures, and confidentiality safeguards. Participants were assured that refusal to participate would not affect the standard of care they would receive. This methodological framework was designed to ensure the accuracy, reproducibility, and clinical relevance of the data obtained. By applying rigorous microbiological standards and appropriate statistical methods, the study sought to contribute valuable insight into the evolving challenge of antibiotic resistance in pediatric UTIs within a major urban healthcare setting.

RESULTS

The study included a total of 422 pediatric patients diagnosed with urinary tract infections over the course of eight months. The mean age of participants was 4.3 ± 3.1 years, with a nearly equal gender distribution of 50.9% males and 49.1% females. The majority of cases (46.9%) were from the 1–5-year age group, followed by 38.4% in the 6–12-year range and 14.7% under one year of age. Among the 422 urine cultures processed, *Escherichia coli* emerged as the most frequently isolated uropathogen, accounting for 69.2% of all cases. *Klebsiella pneumoniae* was the second most common (13.7%), followed by *Proteus mirabilis* (5.7%), *Pseudomonas aeruginosa* (4.3%), and *Enterococcus faecalis* (3.3%), with a small percentage (3.8%) categorized under other miscellaneous organisms. These data are illustrated in Table 1 and visualized in Chart 1. Analysis of antibiotic resistance patterns focused primarily on *E. coli* due to its predominance. Resistance to ampicillin was highest at 84.6%, followed by co-trimoxazole (65.1%) and cefixime (52.3%). Moderate resistance was observed for ceftriaxone (46.9%) and ciprofloxacin (40.8%), whereas gentamicin showed comparatively lower resistance (28.4%). Notably, nitrofurantoin retained good sensitivity, with only 13.4% resistance, and meropenem showed the least resistance at 3.4%. These patterns are detailed in Table 2 and depicted in Chart 2. Multidrug resistance (MDR), defined as resistance to at least one agent in three or more antibiotic classes, was found in 53.4% of *E. coli* isolates. Higher MDR proportions were recorded for *Klebsiella pneumoniae* (65.5%), and 50% of *Pseudomonas aeruginosa* isolates were also identified as MDR. *Proteus mirabilis* and *Enterococcus faecalis* showed MDR rates of 41.7% and 28.6%, respectively. These figures are presented in Table 3. The findings provide a comprehensive snapshot of the bacterial spectrum and antimicrobial resistance trends in pediatric UTI cases from a tertiary care setting in Lahore, revealing high levels of resistance to commonly used antibiotics and highlighting significant rates of multidrug resistance among predominant uropathogens.

Table 1: Demographics

Variable	N (%)
Total Patients	422
Mean Age (years)	4.3 ± 3.1
Gender - Male	215 (50.9%)
Gender - Female	207 (49.1%)
Age Group: <1 year	62 (14.7%)
Age Group: 1-5 years	198 (46.9%)
Age Group: 6-12 years	162 (38.4%)

Table 2: Uropathogens Frequency

Uropathogen	Frequency (n)	Percentage (%)
Escherichia coli	292	69.2
Klebsiella pneumoniae	58	13.7
Proteus mirabilis	24	5.7
Pseudomonas aeruginosa	18	4.3
Enterococcus faecalis	14	3.3
Others	16	3.8

Table 3: E. coli Resistance

Antibiotic	Resistance (%)
Ampicillin	84.6
Co-trimoxazole	65.1
Cefixime	52.3
Ceftriaxone	46.9
Gentamicin	28.4
Nitrofurantoin	13.4
Ciprofloxacin	40.8
Meropenem	3.4

Table 4: MDR by Organism

Organism	MDR Cases (n)	MDR (%)
Escherichia coli	156	53.4
Klebsiella pneumoniae	38	65.5
Proteus mirabilis	10	41.7
Pseudomonas aeruginosa	9	50
Enterococcus faecalis	4	28.6

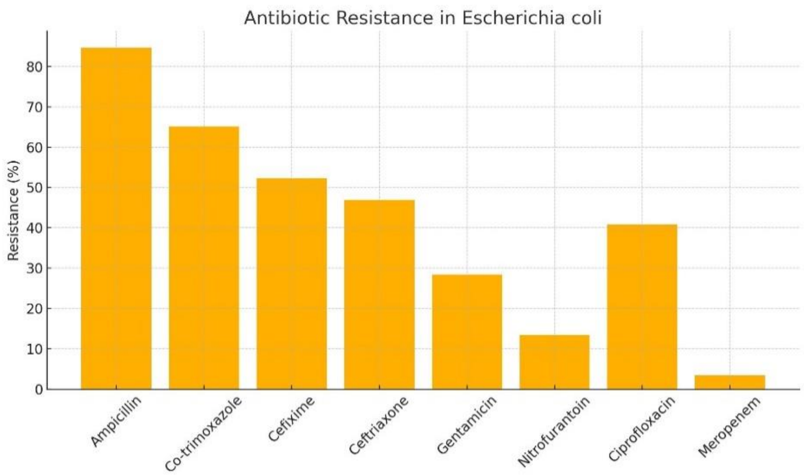

Figure 1 Antibiotic Resistance in Escherichia Coli

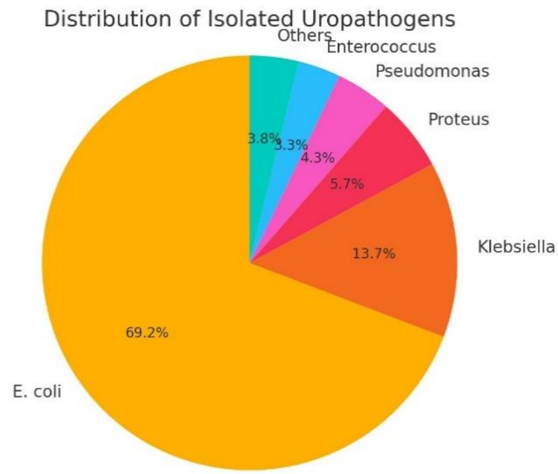

Figure 2Distribution of Isolated Uropathogens

DISCUSSION

The findings of this study provide a critical snapshot of antibiotic resistance trends among pediatric uropathogens in a major urban center of Pakistan. The predominance of *Escherichia coli* as the leading causative organism in pediatric UTIs aligns with international and regional studies, affirming its etiological consistency across diverse populations (16). However, the high rates of resistance observed, particularly against ampicillin (84.6%) and co-trimoxazole (65.1%), are alarming and highlight a significant erosion in the efficacy of traditionally relied-upon empirical therapies. The current data closely mirrors trends reported in recent literature from the region. A study, noted substantial resistance to ampicillin and ceftriaxone, with a concerning rise in multidrug-resistant (MDR) organisms such as *Klebsiella pneumoniae* and *Enterococcus faecalis* (17). Similarly, global studies have increasingly recognized *E. coli* and *Klebsiella* species as significant MDR threats, with several isolates exhibiting resistance to three or more antibiotic classes (18). Notably, our study found over 53% of *E. coli* and 65.5% of *Klebsiella pneumoniae* isolates to be MDR, comparable to the figures cited in regional surveillance data from Bangladesh and Saudi Arabia (18,19)

One of the notable strengths of this study lies in its prospective cross-sectional design and the relatively large sample size of over 400 pediatric patients. This allows for a more reliable estimation of resistance patterns and lends statistical power to subgroup analysis. Furthermore, strict adherence to CLSI standards in antimicrobial susceptibility testing and stratification of resistance by pathogen enhances the robustness of the microbiological data. Despite these strengths, there are inherent limitations. Being a single-center hospital-based study, the findings may not be entirely generalizable to other regions or community-acquired cases, where the bacterial spectrum and resistance pressures may differ. Additionally, the study did not stratify data based on prior antibiotic exposure, hospitalization history, or recurrent infections—factors known to influence resistance patterns. Moreover, while resistance phenotypes were well-characterized, no molecular typing or ESBL testing was conducted, which could have provided deeper insights into the mechanisms driving MDR trends (20,21).

Nonetheless, the low resistance rates observed for nitrofurantoin (13.4%) and meropenem (3.4%) in *E. coli* are encouraging and echo findings from Portugal and India, where nitrofurantoin remains a viable option for uncomplicated pediatric UTIs (22,23) These findings support the recommendation of nitrofurantoin as a preferred empirical agent, particularly for lower urinary tract infections, while reserving carbapenems like meropenem for resistant or complicated cases. This study underscores the urgent need for the implementation of pediatric-specific antibiograms to guide empirical antibiotic selection more effectively. The increasing presence of MDR pathogens and diminishing effectiveness of first-line antibiotics call for renewed emphasis on antimicrobial stewardship, particularly in pediatric settings where empirical therapy is common. Future research should aim to incorporate multicenter data, molecular resistance profiling, and longitudinal surveillance to capture temporal trends and inform regional and national treatment guidelines. In conclusion, the high burden of antibiotic resistance observed in pediatric UTIs from Lahore reflects broader global concerns and emphasizes the need for routine surveillance, rational prescribing, and localized treatment protocols. Interventions targeting antibiotic stewardship and the development of age-specific empirical guidelines are essential to preserve antibiotic efficacy for future generations.

CONCLUSION

This study highlights a high prevalence of multidrug-resistant uropathogens in pediatric UTIs, with *Escherichia coli* as the predominant organism. The findings underscore the urgent need for local antibiograms to guide empirical therapy and reinforce antimicrobial stewardship in pediatric care. Continued surveillance is vital to curb resistance and ensure effective treatment outcomes.

AUTHOR CONTRIBUTION

Author	Contribution
Saleem Asghar Shar Baloch*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Aqib Ashraf	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Shaista Hamid	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Rabia Azam	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Tehreem Abbas	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Sidra Rafique	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Malghalara Masood	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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