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Antibiotic Sensitivity and Resistance Profile of *E. Coli* and *Klebsiella* Isolated from Urine of Pediatric Patients at a Tertiary Care Hospital in Bangladesh

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Abstract **Original Research Article**

Background: Urinary tract infections (UTIs) are a common cause of morbidity among pediatric patients, with *Escherichia coli* (*E. Coli*) and *Klebsiella* spp. accounting for the majority of cases. The emergence of antimicrobial resistance, particularly multidrug-resistant (MDR) and extended-spectrum β-lactamase (ESBL)-producing strains, has significantly compromised the effectiveness of empirical treatment options. Continuous monitoring of local resistance patterns is therefore critical to inform antibiotic stewardship strategies and optimize clinical outcomes in pediatric care settings. ***Aim:*** This study aimed to determine the antibiotic sensitivity and resistance profiles of *Escherichia coli* and *Klebsiella* species isolated from urine samples of pediatric patients at a tertiary care hospital in Bangladesh. ***Methods:*** This cross-sectional study was conducted at the Department of Pediatric Nephrology, Bangladesh Medical University (BMU), Dhaka, Bangladesh from September 2024 to August 2025. A total of 230 pediatric patients aged 1 month to 18 years, presenting with clinical features suggestive of urinary tract infection (UTI) were included using a purposive sampling technique. Patients who had received antibiotics within the previous 48 hours or had known structural or congenital abnormalities of the urinary tract were excluded. Midstream urine samples were collected aseptically and cultured on Cysteine-Lactose-Electrolyte-Deficient (CLED) and MacConkey agar using the standard loop method. Significant bacteriuria was defined as a colony count of $\geq 10^5$ CFU/ml. Isolates of *Escherichia coli* and *Klebsiella* spp. were identified using standard biochemical methods. Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion technique on Mueller-Hinton agar, and results were interpreted according to Clinical & Laboratory Standards Institute (CLSI) 2024 guidelines. Data were analyzed accordingly and compared with statistical tests. ***Results:*** Out of 230 pediatric urine samples, 208 (90.4%) yielded significant bacterial growth, with *Escherichia coli* (57.4%) and *Klebsiella* spp. (33.0%) being the predominant uropathogens. High resistance was observed against ampicillin (87.5%), amoxicillin–clavulanate (68.8%), and third-generation cephalosporins (54–63%), while carbapenems and amikacin remained highly effective, showing the lowest resistance (<20%). Multidrug resistance (MDR) was detected in 47.6% of isolates, and 42.8% were ESBL producers. A significant association was found between ESBL production and MDR ($p < 0.001$), with 79.8% of ESBL-positive strains exhibiting multidrug resistance. Infants showed the highest overall resistance, indicating an age-related trend in antimicrobial susceptibility. ***Conclusion:*** Antibiotic resistance among pediatric uropathogens is alarmingly high, particularly for first-line agents such as ampicillin and cephalosporins. The strong association between ESBL production and multidrug resistance highlights the need for routine susceptibility testing and judicious antibiotic use. Carbapenems and amikacin remain effective and should be reserved for resistant or complicated cases to preserve their efficacy.

Keywords: Antimicrobial Resistance (AMR), *Escherichia Coli*, *Klebsiella* spp., Extended-Spectrum β-Lactamase (ESBL), Multidrug-Resistant (MDR).

1. INTRODUCTION

Urinary tract infections (UTIs) represent a significant cause of morbidity among pediatric patients globally and are particularly concerning due to their potential for recurrence [1]. Among the etiological agents, *Escherichia coli* and *Klebsiella* spp. are the predominant gram-negative pathogens implicated in both community-acquired and hospital-associated UTIs in children [2, 3]. Timely initiation of appropriate empirical antibiotic therapy is crucial in pediatric UTIs to prevent complications; however, this is increasingly challenged by the global surge in antimicrobial resistance (AMR). Resistance is particularly concerning in *E. coli* and *Klebsiella* spp., which have exhibited a growing capacity to produce extended-spectrum β-lactamases (ESBLs), rendering them resistant to penicillins, cephalosporins, and even some β-lactamase inhibitor combinations [4, 5]. Such strains are frequently multidrug-resistant (MDR), often necessitating the use of carbapenems or aminoglycosides; agents that are less accessible and carry higher toxicity risks in pediatric care [6, 7]. Inappropriate and unregulated antibiotic use, delayed laboratory diagnostics, and insufficient antimicrobial stewardship programs in many low- and middle-income countries exacerbate this crisis [8, 9]. Moreover, regional variation in resistance patterns makes generalized treatment guidelines unreliable. Therefore, surveillance of local antimicrobial susceptibility profiles is essential to ensure the efficacy of empirical therapy, reduce treatment failures, and mitigate the spread of resistant strains [10, 11].

Despite the clinical importance of UTIs in children, limited studies in Bangladesh have addressed the antibiotic resistance patterns of urinary *E. coli* and *Klebsiella* isolates specifically within pediatric population. Pediatric nephrology units, which manage complex UTI cases, are particularly vulnerable to resistance-driven treatment challenges. In this context, the present study was undertaken to investigate the antibiotic sensitivity and resistance profiles of *E. coli* and *Klebsiella* spp. isolated from urine specimens of pediatric patients at a tertiary care hospital in Bangladesh.

2. METHODS

Study Design and Setting:

A cross-sectional study was conducted at the Department of Pediatric Nephrology, Bangladesh Medical University (BMU), Dhaka, Bangladesh over a 12-month period from September 2024 to August 2025. The study aimed to assess the antibiotic sensitivity and resistance profiles of *Escherichia coli* and *Klebsiella* spp. isolated from urine samples of pediatric patients clinically suspected of urinary tract infections (UTIs).

Study Population and Sample Size:

A total of 230 pediatric patients, aged between 1 month and 18 years were included in the study based on predefined clinical criteria indicative of UTIs (e.g. fever, dysuria, urgency, suprapubic tenderness). Patients who had received systemic antibiotics within 48 hours prior to sample collection, or those with known congenital urinary tract abnormalities, were excluded to minimize confounding effects.

Sample Collection and Processing:

Midstream, clean-catch urine samples were collected aseptically in sterile, wide-mouth containers. In non-toilet-trained children, urine was collected using sterile urine collection bags following proper perineal cleansing. All samples were processed within two hours of collection. Each specimen was inoculated on Cysteine Lactose Electrolyte Deficient (CLED) agar and MacConkey agar using a calibrated 0.001 ml loop and incubated aerobically at 37°C for 18–24 hours. Significant bacteriuria was defined as a colony count of $\geq 10^5$ colony-forming units (CFU)/ml.

Bacterial Identification and Antibiotic Susceptibility Testing:

Isolates were identified based on colony morphology, gram staining, and standard biochemical tests (e.g., indole, citrate utilization, triple sugar iron, urease tests). Antibiotic susceptibility testing was carried out using the Kirby-Bauer disk diffusion method on Mueller-Hinton agar plates, and results were interpreted according to the Clinical and Laboratory Standards Institute (CLSI) guidelines, 2024 edition. Antibiotics tested included ampicillin, amoxicillin-clavulanate, cefotaxime, ceftazidime, ceftriaxone, cefepime, tetracycline, ciprofloxacin, levofloxacin, gentamicin, amikacin, nitrofurantoin, piperacillin-tazobactam, meropenem and imipenem.

Quality Control:

Standard reference strains (*E. coli* ATCC 25922 and *Klebsiella pneumoniae* ATCC 700603) were used to validate all identification and susceptibility procedures.

Statistical Analysis:

Data were entered and analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics were calculated for bacterial frequencies and resistance patterns. Associations between bacterial species and resistance profiles were assessed using the Chi-square (χ) test. A p-value of <0.05 was considered statistically significant.

Ethical Consideration:

Informed written consent was obtained from the parents or legal guardians of all participants prior to enrollment. Patient confidentiality and data anonymity were maintained throughout the study, in accordance with the Declaration of Helsinki.

3. RESULTS AND OBSERVATIONS

This study was aimed to inform empirical treatment strategies and support antimicrobial stewardship initiatives. A total of 230 urine samples from pediatric patients were analyzed, of which 98 samples from male pediatric patients and 132 samples from female pediatric patients. It was found that most UTI cases occurred in children aged 1 - 5 years (38.7%), with a higher prevalence in females (57.4%). Fever (75.7%) was the most common symptom, followed by dysuria (46.1%) and urinary urgency or frequency (38.7%). A previous UTI history was reported in 20.4% of patients, and 23.5% required hospital admission, reflecting the clinical significance of pediatric UTIs in a tertiary care setting (Table- 1).

Table- 1: Demographic and clinical characteristics of pediatric patients (N= 230)

Variables	Frequency (n)	Percentage (%)
Age Group		
<1 year	32	13.9%
1–5 years	89	38.7%
6–12 years	71	30.9%
13–18 years	38	16.5%
Sex		
Male	98	42.6%
Female	132	57.4%
Presenting Symptoms		
Fever	174	75.7%
Dysuria	106	46.1%
Urinary urgency/frequency	89	38.7%
Lower abdominal/suprapubic pain	72	31.3%
Vomiting/nausea	33	14.3%
Past UTI History	47	20.4%
Hospital Admission Required	54	23.5%

In this study, *E. coli* was the most frequently isolated pathogen, accounting for 57.4% of culture-positive cases, followed by *Klebsiella* spp. (33.0%). A small fraction (9.6%) of samples yielded no growth or were considered contaminated (Table- 2).

Table- 2: Distribution of bacterial isolates from urine cultures (N= 230)

Bacterial Species	Number of Isolates (n)	Percentage (%)
Escherichia coli	132	57.4%
Klebsiella spp.	76	33.0%
No growth/contaminated	22	9.6%
Total	230	100%

Data analysis revealed that *E. coli* and *Klebsiella* spp. exhibited high resistance to ampicillin (84.1% and 93.4%, respectively) and to several β-lactam antibiotics, including cefotaxime and ceftazidime. Moderate resistance was also observed to fluoroquinolones and tetracycline. In contrast, both organisms demonstrated strong susceptibility to amikacin, piperacillin-tazobactam, and particularly to carbapenems (imipenem and meropenem), suggesting these agents remain effective treatment options in settings with high multidrug resistance (Table- 3).

Table- 3: Antibiotic susceptibility profile of *E. coli* and *Klebsiella* spp. isolated from urine samples (n= 208)

Antibiotics	*E. coli* (n = 132)		*Klebsiella* spp. (n = 76)	
	Sensitive n (%)	Resistant n (%)	Sensitive n (%)	Resistant n (%)
Ampicillin	21 (15.9%)	111 (84.1%)	5 (6.6%)	71 (93.4%)
Amoxicillin-clavulanate	47 (35.6%)	85 (64.4%)	18 (23.7%)	58 (76.3%)
Cefotaxime	52 (39.4%)	80 (60.6%)	26 (34.2%)	50 (65.8%)
Ceftazidime	58 (43.9%)	74 (56.1%)	29 (38.2%)	47 (61.8%)
Ceftriaxone	63 (47.7%)	69 (52.3%)	31 (40.8%)	45 (59.2%)
Cefepime	68 (51.5%)	64 (48.5%)	35 (46.1%)	41 (53.9%)
Ciprofloxacin	66 (50.0%)	66 (50.0%)	28 (36.8%)	48 (63.2%)

Levofloxacin	69 (52.3%)	63 (47.7%)	31 (40.8%)	45 (59.2%)
Tetracycline	59 (44.7%)	73 (55.3%)	24 (31.6%)	52 (68.4%)
Nitrofurantoin	97 (73.5%)	35 (26.5%)	44 (57.9%)	32 (42.1%)
Gentamicin	88 (66.7%)	44 (33.3%)	49 (64.5%)	27 (35.5%)
Amikacin	110 (83.3%)	22 (16.7%)	60 (78.9%)	16 (21.1%)
Piperacillin-tazobactam	117 (88.6%)	15 (11.4%)	65 (85.5%)	11 (14.5%)
Imipenem	123 (93.2%)	9 (6.8%)	71 (93.4%)	5 (6.6%)
Meropenem	125 (94.7%)	7 (5.3%)	70 (92.1%)	6 (7.9%)

Table- 4 demonstrates that 47.6% of the urinary isolates exhibited multidrug resistance (MDR), with similar rates observed in *E. coli* (46.2%) and *Klebsiella* spp. (50.0%). ESBL production was also notable, present in 40.9% of *E. coli* and 46.1% of *Klebsiella* isolates (Table- 4).

Table- 4: Prevalence of MDR and ESBL-Producing isolates among *E. coli* and *Klebsiella* spp. (n = 208)

Bacterial Species	**MDR Isolates n (%)**	**Non-MDR n (%)**	**ESBL Producers n (%)**	**Non-ESBL n (%)**
Escherichia coli (n = 132)	61 (46.2%)	71 (53.8%)	54 (40.9%)	78 (59.1%)
Klebsiella spp. (n = 76)	38 (50.0%)	38 (50.0%)	35 (46.1%)	41 (53.9%)
Total (n = 208)	99 (47.6%)	109 (52.4%)	89 (42.8%)	119 (57.2%)

In this study critical age-specific resistance trends were observed among uropathogens isolated from pediatric patients. Ampicillin showed the highest overall resistance (87.5%), reaching 100% among adolescents, indicating it is no longer effective as empirical therapy. Resistance to third-generation cephalosporins and fluoroquinolones was consistently moderate to high across all age groups (54 - 63%), limiting their utility without prior sensitivity testing. Notably, carbapenems (imipenem and meropenem) demonstrated the lowest resistance rates (6.3 - 6.7%) and remained effective across all ages, as did amikacin (18.3%). Infants (<1 year) exhibited the highest resistance burden across nearly all antibiotics, emphasizing the importance of cautious antibiotic use in this vulnerable group (Table 5).

Table 5. Antibiotic resistance pattern by age group (n = 208)

Antibiotics	**<1 year (n=30) n (%)**	**1–5 years (n=80) n (%)**	**6–12 years (n=60) n (%)**	**13–18 years (n=38) n (%)**	**Total (n=208) n (%)**
Ampicillin	27 (90.0%)	69 (86.3%)	48 (80.0%)	38 (100%)	182 (87.5%)
Amoxicillin-clavulanate	21 (70.0%)	55 (68.8%)	41 (68.3%)	26 (68.4%)	143 (68.8%)
Cefotaxime	19 (63.3%)	50 (62.5%)	37 (61.7%)	24 (63.2%)	130 (62.5%)
Ceftazidime	18 (60.0%)	46 (57.5%)	35 (58.3%)	22 (57.9%)	121 (58.2%)
Ceftriaxone	17 (56.7%)	43 (53.8%)	33 (55.0%)	21 (55.3%)	114 (54.8%)
Cefepime	16 (53.3%)	40 (50.0%)	30 (50.0%)	19 (50.0%)	105 (50.5%)
Ciprofloxacin	17 (56.7%)	43 (53.8%)	34 (56.7%)	20 (52.6%)	114 (54.8%)
Levofloxacin	15 (50.0%)	39 (48.8%)	31 (51.7%)	23 (60.5%)	108 (51.9%)
Tetracycline	19 (63.3%)	48 (60.0%)	36 (60.0%)	22 (57.9%)	125 (60.1%)
Nitrofurantoin	9 (30.0%)	25 (31.3%)	21 (35.0%)	12 (31.6%)	67 (32.2%)
Gentamicin	10 (33.3%)	28 (35.0%)	20 (33.3%)	13 (34.2%)	71 (34.1%)
Amikacin	5 (16.7%)	15 (18.8%)	11 (18.3%)	7 (18.4%)	38 (18.3%)
Pip–tazobactam	3 (10.0%)	10 (12.5%)	7 (11.7%)	6 (15.8%)	26 (12.5%)
Imipenem	2 (6.7%)	5 (6.3%)	3 (5.0%)	4 (10.5%)	14 (6.7%)
Meropenem	2 (6.7%)	4 (5.0%)	3 (5.0%)	4 (10.5%)	13 (6.3%)

A strong and statistically significant association was observed between ESBL production and multidrug resistance (MDR) among uropathogens (p<0.001). Among ESBL-producing isolates, 79.8% were MDR, compared to only 23.5% of ESBL-negative isolates (Table 6).

Table-6: Association between ESBL production and MDR in uropathogenic isolates (n = 208)

ESBL Status	MDR n (%)	Non-MDR n (%)	Total n (%)	Chi-square test
ESBL-positive	71 (79.8%)	18 (20.2%)	89 (42.8%)	$\chi 2$= 64.58
ESBL-negative	28 (23.5%)	91 (76.5%)	119 (57.2%)	p<0.001*
Total	99 (47.6%)	109 (52.4%)	208 (100%)	

*Significant

4. DISCUSSION

Urinary tract infections (UTIs) remain one of the most common bacterial infections in the pediatric population and present a major clinical and public health challenge, particularly in developing countries. Timely diagnosis and appropriate antibiotic treatment are crucial to prevent complications such as renal scarring and further renal injury. However, the rising burden of antimicrobial resistance, including multidrug-resistant (MDR) and extended-spectrum β-lactamase (ESBL)-producing organisms, has significantly compromised the effectiveness of empirical therapies in many low-resource settings. This study aimed to explore the antimicrobial susceptibility patterns of uropathogenic *Escherichia coli* and *Klebsiella* spp. in pediatric patients at a tertiary care center in Bangladesh, alongside demographic and clinical correlations.

In the present study, the age distribution of pediatric UTI cases showed that the majority occurred in the 1 - 5 years group (38.7%), followed by children aged 6 - 12 years (30.9%). This aligns with findings from Akter *et al.*,[9] and Ali *et al.*,[12]; who similarly reported high UTI prevalence in younger children, attributing it to toilet-training, immature immunity, and poor personal hygiene in early childhood. A female predominance (57.4%) was observed, consistent with prior research including Ahmad *et al.*,[2] and Barwa *et al.*,[10]; supporting the role of anatomical factors in predisposing girls to UTIs.

Fever (75.7%) was the most common symptom, supporting the diagnostic challenge in younger children, where fever may be the only presenting feature of a UTI. Dysuria (46.1%), urgency/frequency (38.7%), and lower abdominal pain (31.3%) were also notable and reflect typical lower urinary tract symptoms. Similar symptom profiles were observed in studies by Mahjabin *et al.*,[13] and Smriti *et al.*,[5] indicating clinical overlap across different pediatric age groups and healthcare settings.

Previous history of UTI was reported in 20.4% of cases, indicating recurrence; a concern particularly in children with anatomical anomalies or prior antibiotic exposure, as suggested by Chowdhury *et al.*,[4]. Additionally, 23.5% of patients required hospitalization, reflecting either severity of infection or complications such as resistance. This finding is comparable to data from Das *et al.*,[3], where referral-level facilities also reported high admission rates due to multidrug-resistant infections.

In the present study, *Escherichia coli* emerged as the most frequently isolated uropathogen (57.4%) from pediatric urine cultures, followed by *Klebsiella* spp. (33.0%). This finding aligns with several regional studies that consistently identify *E. coli* as the leading cause of urinary tract infections (UTIs) in children. For instance, Mahjabin *et al.*,[13] reported *E. coli* in 60.5% and *Klebsiella* spp. in 28.3% of pediatric UTI cases at a tertiary hospital in Bangladesh, featuring their dominant role in community- and hospital-acquired UTIs. Similarly, Rahman *et al.*,[1] found *E. coli* to be the most prevalent pathogen (65.3%) among UTI patients, confirming its continued clinical significance in this region.

The significant presence of *Klebsiella* spp. in our cohort is particularly noteworthy, as it is often associated with increased antimicrobial resistance, biofilm formation, and nosocomial transmission. Karedla *et al.*,[14] emphasized the high resistance potential of *Klebsiella* spp. in pediatric isolates, which necessitates targeted surveillance and judicious antibiotic selection. This observation is also supported by Negm *et al.*,[15]; who identified *Klebsiella* as a major pathogen in urinary samples with elevated resistance rates, particularly in hospital settings.

A small proportion (9.6%) of samples yielded no growth or were considered contaminated, which is acceptable in pediatric populations where clean-catch or catheterized urine collection can be technically challenging. As Gandham and Arumugam [16] noted, pre-analytical factors including sample collection technique, prior antibiotic exposure, and delayed transport may contribute to culture-negative results in pediatric urine samples.

In the present study, the antibiotic susceptibility patterns of 208 uropathogenic isolates revealed high resistance rates to commonly used first-line antibiotics. *Escherichia coli* showed the highest resistance to ampicillin (84.1%), followed by amoxicillin–clavulanate (64.4%) and third-generation cephalosporins such as cefotaxime (60.6%), ceftriaxone (52.3%), and ceftazidime (56.1%). Similarly, *Klebsiella* spp. exhibited marked resistance to ampicillin (93.4%) and cephalosporins, with cefotaxime resistance reaching 65.8%. These findings are consistent with those of Mahjabin *et al.*,[13] and Ahmad *et al.*,[2]; who reported widespread resistance to β-lactam antibiotics in pediatric urinary isolates in Bangladesh.

Fluoroquinolones such as ciprofloxacin and levofloxacin exhibited moderate resistance (50%) in *E. coli*, while *Klebsiella* spp. showed slightly higher resistance levels. This suggests declining efficacy of

these agents, which have historically been reserved for complicated cases. Resistance to tetracycline was also notable in both species, reflecting patterns of overuse and cross-resistance documented in regional studies [1, 10].

In contrast, aminoglycosides (amikacin and gentamicin) and nitrofurantoin demonstrated relatively higher efficacy, with *E. coli* showing 83.3% susceptibility to amikacin and 73.5% to nitrofurantoin. These findings agree with Akter *et al.*,[9], who observed similar susceptibility patterns in uropathogens from pediatric patients. Piperacillin–tazobactam, imipenem, and meropenem remained the most effective antibiotics, with susceptibility rates exceeding 90% in both *E. coli* and *Klebsiella* spp., highlighting their continued role as last-line agents. Gandham and Arumugam [16] also emphasized the preserved sensitivity of carbapenems, although caution was urged due to the risk of resistance development under selection pressure. The overall susceptibility trends observed in this study highlight a disturbing rise in resistance to empirical therapies. This necessitates routine culture and sensitivity testing before initiating treatment, especially in high-risk pediatric populations. Empirical antibiotic guidelines must be tailored based on ongoing surveillance data to optimize outcomes and delay the emergence of resistance.

In the present study, multidrug resistance (MDR) was observed in 47.6% of all uropathogenic isolates, with *Klebsiella* spp. (50.0%) showing slightly higher MDR prevalence than *E. coli* (46.2%). A similarly alarming rate was reported by Ahmad *et al.*,[2], who found that over 50% of urinary isolates from pediatric patients demonstrated MDR, particularly to β-lactams, fluoroquinolones, and aminoglycosides. These findings reflect the increasing difficulty in managing community- and hospital-acquired UTIs using conventional empiric therapy.

The rate of extended-spectrum β-lactamase (ESBL) production was also high in both species: 40.9% in *E. coli* and 46.1% in *Klebsiella* spp. These figures are consistent with the report by Mahjabin *et al.*,[13], where 42.3% of *E. coli* and 49.0% of *Klebsiella* isolates were ESBL-producers, particularly in hospitalized pediatric patients. The production of ESBLs not only confers resistance to third-generation cephalosporins but is also associated with co-resistance to other antibiotic classes, severely narrowing therapeutic options.

In the present study, age-stratified analysis revealed that resistance to commonly used antibiotics was high across all pediatric age groups, with the highest rates notably observed in infants (<1 year). Ampicillin resistance exceeded 90% in this group, while third-generation cephalosporins such as cefotaxime and ceftriaxone also showed resistance rates above 60%, consistent with findings reported by Mahjabin *et al.*,[13] and Ali *et al.*,[12], who highlighted the burden of resistance in neonates and infants due to higher exposure to empirical antibiotics during early febrile illnesses.

While resistance to amoxicillin–clavulanate and fluoroquinolones (ciprofloxacin, levofloxacin) remained consistently high across all age groups (approximately 50 - 70%), a relatively lower resistance was noted for carbapenems (imipenem and meropenem) and amikacin. This trend supports the status of these agents as last-line therapies, a point also emphasized in regional studies by Barwa *et al.*,[10] and Akter *et al.*,[9]. The overall resistance to imipenem and meropenem remained below 10% across age groups, supporting their retained efficacy but also point out the necessity of stewardship to delay the emergence of carbapenem-resistant strains. Remarkably, nitrofurantoin resistance was lowest in infants (30%) and remained stable across age categories. Given its oral availability and urinary tract specificity, nitrofurantoin remains a viable option for empirical therapy in uncomplicated lower UTIs, particularly in older children, a recommendation also supported by Ahmad *et al.*,[2].

Age-related differences in resistance may reflect patterns of antibiotic exposure, causal health conditions, or hospitalization history. Our findings are comparable with previous studies conducted in similar healthcare settings [17, 18, 19]. Younger children are more frequently exposed to broad-spectrum antibiotics early in life, often empirically, which contributes to the development of resistance. As highlighted by Rahman *et al.*,[1], repeated empirical therapy in children without prior culture confirmation is a major driver of resistance in this population.

In the present study, a significant association was observed between extended-spectrum β-lactamase (ESBL) production and multidrug resistance (MDR) among uropathogenic isolates, with 79.8% of ESBL-producing strains also demonstrating MDR characteristics ($\chi^2 = 64.58$, $p<0.001$). This strong correlation highlights the clinical challenge posed by ESBL-producing organisms, which often harbor co-resistance to multiple classes of antibiotics, significantly narrowing effective treatment options. These findings are consistent with prior reports. Mahjabin *et al.*,[13] reported a comparable association, where 76% of ESBL-positive isolates in children also exhibited MDR traits, particularly resistance to fluoroquinolones and aminoglycosides. Similarly, Rahman *et al.*,[1] demonstrated that pediatric *E. coli* and *Klebsiella* isolates producing ESBLs were significantly more likely to be multidrug-resistant, necessitating the use of carbapenems or other reserve antibiotics.

The molecular mechanisms causing this co-resistance are often plasmid-mediated, enabling simultaneous carriage of ESBL genes (such as bla_CTX-M, bla_TEM) and resistance determinants for other drug classes (e.g., qnr, aac(6′)-Ib) [20]. This linkage facilitates

rapid horizontal gene transfer in hospital environments, particularly among Enterobacteriaceae, as emphasized by Barwa *et al.*,[10].

Clinically, the ESBL- MDR overlap significantly complicates empirical therapy in pediatric UTIs. Inappropriate initial treatment can lead to treatment failure, prolonged hospitalization, and increased risk of renal complications. This highlights the need for early identification of ESBL producers using routine phenotypic screening, particularly in tertiary-level care centers where antimicrobial pressure is high. Overall, the strong statistical correlation between ESBL production and MDR observed in this study emphasizes the urgency of implementing antimicrobial stewardship, infection control practices, and continuous local resistance surveillance to guide targeted therapy and preserve antibiotic efficacy in the pediatric population.

5. CONCLUSION

This study demonstrates a substantial burden of antimicrobial resistance among pediatric urinary isolates in a tertiary care setting, with nearly half of the isolates exhibiting multidrug resistance and over 40% producing ESBLs. The significant association between ESBL production and MDR emphasizes the critical need for routine ESBL screening in clinical microbiology workflows. Empirical treatment strategies must be guided by updated local resistance data, and the continued effectiveness of carbapenems and amikacin must be safeguarded through antimicrobial stewardship. Age-specific resistance trends, particularly in infants, further support the call for personalized, evidence-based therapeutic approaches to pediatric urinary tract infections.

Recommendations

Routine urine culture should be encouraged to support targeted therapy in pediatric UTIs. Empirical treatment protocols must be regularly updated in line with local resistance trends. Strengthening antimicrobial stewardship is essential to reduce inappropriate antibiotic use. Enhanced surveillance and timely dissemination of antibiograms will improve evidence-based prescribing. Clinician training in proper sample collection and antibiotic selection should also be prioritized to improve diagnostic accuracy and treatment outcomes.

Limitations

This was a single-center study; therefore, it limits generalizability. Molecular resistance profiling was not performed. The cross-sectional design precluded outcome analysis. Non-bacterial pathogens were not included in this cohort. Moreover, clinical risk factors were not assessed in details.

Conflicts of Interest:

Authors declared that there was no conflict of interest regarding this publication.

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