BACTERIOLOGICAL PATTERN OF URINARY TRACT INFECTION IN CHILDREN PRESENTING TO PEDIATRIC DEPARTMENT OF MARDAN MEDICAL COMPLEX

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How to cite this article

Naeem P, Ahmad K, Khan MQ, Shah M, Pervez K, Raza U. Bacteriological Pattern of Urinary Tract Infection in Children Presenting to Pediatric Department of Mardan Medical Complex. J Gandhara Med Dent Sci. 2026;13(3):41-46. https://doi.org/10.37762/jgmds.13-3.911

Date of Submission: 13-04-2026
Date Revised: 05-05-2026
Date Acceptance: 22-05-2026

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ABSTRACT

OBJECTIVES

This study aimed to determine the bacteriological profile and antibiotic susceptibility of culture-confirmed urinary tract infections among children presenting to the Pediatric Department of Mardan Medical Complex.

METHODOLOGY

This hospital-based cross-sectional study was conducted from April 2025 to October 2025. A total of 109 children aged 1 month to 12 years with clinically suspected urinary tract infection were enrolled through consecutive sampling. Urine microscopy, nitrite testing, culture, bacterial identification, and Kirby-Bauer disc diffusion susceptibility testing were performed. Data were analyzed using SPSS version 25. Frequencies, percentages, 95% confidence intervals, Chi-square/Fisher-Freeman-Halton exact test, Cramer's V, and binary logistic regression were applied.

RESULTS

The mean age was 6.72 ± 3.43 years, and 67 children (61.5%) were female. Urine culture was positive in 53 cases (48.6%; 95% CI: 39.4-57.9%). Among culture-positive isolates, Staphylococcus spp. was most frequent, 11 (20.8%; 95% CI: 12.0-33.5%), followed by Enterococcus spp., 10 (18.9%), Proteus spp., 9 (17.0%), Escherichia coli, 8 (15.1%), Klebsiella spp., 8 (15.1%), and Pseudomonas spp. 7 (13.2%). Cefixime showed the highest sensitivity (30; 56.6%). Amoxicillin and co-amoxiclav showed the highest resistance, 31 (58.5%) each. No independent predictor of culture positivity was identified on logistic regression.

CONCLUSION

Culture confirmation remains essential in suspected pediatric UTI. The predominance of Staphylococcus spp. should be interpreted cautiously due to possible contamination and lack of species-level confirmation. Organism-wise susceptibility surveillance is recommended.

KEYWORDS: *Urinary Tract Infection, Children, Bacteriological Pattern, Antibiotic Resistance, Pediatric UTI*

INTRODUCTION

Urinary tract infection (UTI) is one of the common bacterial infections in children and remains an important cause of pediatric morbidity. If not diagnosed and treated appropriately, UTI may lead to recurrent infection, renal scarring, hypertension, and long-term renal impairment.[1] Diagnosis in children can be challenging because clinical features vary with age. Infants and younger children may present with non-specific symptoms such as fever, irritability, vomiting, and poor feeding, whereas older children more commonly report dysuria, increased urinary frequency, urgency, abdominal pain, or flank discomfort. Therefore, clinical suspicion should be supported by urine microscopy and culture confirmation.[2,3] For diagnostic accuracy, pediatric UTIs should be differentiated from asymptomatic bacteriuria and sample contamination. A diagnosis of UTI generally requires compatible clinical features, pyuria, and significant growth of a recognized uropathogen on urine culture. In clean-catch midstream urine, significant bacteriuria is commonly defined as growth of a single organism at $\geq 10^5$ CFU/mL, while lower colony-count thresholds may be used for catheter-collected specimens when supported by symptoms and pyuria.[4] This distinction is important because culture positivity without symptoms may represent asymptomatic bacteriuria, and mixed growth or low colony counts may indicate contamination rather than true infection.[5,6] The epidemiology of pediatric UTI varies according to age and gender. During infancy, boys may have a relatively higher frequency of UTI, particularly in the presence of urinary tract anomalies. In contrast, after infancy, girls are more commonly affected due to anatomical factors, such as a shorter urethra and the proximity of the urethral opening to the

perineum.[7,8] These differences make age- and gender-specific assessment important in pediatric UTI evaluation.[9] *Escherichia coli* remains the most frequently reported uropathogen in children worldwide, followed by organisms such as *Klebsiella* spp., *Proteus* spp., *Enterococcus* spp., *Pseudomonas* spp., and selected staphylococcal species.[10] However, organism distribution may vary by setting, prior antibiotic exposure, urine collection technique, outpatient or inpatient status, and whether cases are uncomplicated, recurrent, or hospital-acquired. Therefore, local bacteriological surveillance is necessary before recommending empirical antibiotic therapy.[11] Antimicrobial resistance among pediatric uropathogens is increasing, particularly against commonly used antibiotics. This has important clinical implications because inappropriate empirical treatment may lead to persistent infection, recurrence, prolonged hospital stay, and increased healthcare costs. Culture and antimicrobial susceptibility testing are, therefore, essential for guiding appropriate therapy. Ceftriaxone is a parenteral third-generation cephalosporin and should not be described as an oral agent; oral options for pediatric UTI may include cefixime or other appropriate antibiotics, depending on local susceptibility patterns.[12] In Pakistan, updated local data regarding pediatric UTI pathogens and antibiotic resistance patterns remain limited, especially from tertiary-care hospitals in Khyber Pakhtunkhwa. Region-specific evidence is needed to support rational antibiotic use and improve clinical management. Therefore, this study was conducted to determine the bacteriological profile and antibiotic susceptibility of urinary tract infections among children presenting to the Pediatric Department of Mardan Medical Complex.

METHODOLOGY

The cross-sectional descriptive study was conducted in the Department of Pediatrics at Mardan Medical Complex over six months from April to October 2025. Ethical approval was obtained from the Ethical Committee of Bacha Khan Medical College (Ref No. 504/BKMC dated 16-05-2024), and the study synopsis was approved by the College of Physicians and Surgeons Pakistan (Ref No. CPSP/REU/PED-2022-028-7203 dated April 12, 2025). Written informed consent was obtained from parents or legal guardians, and confidentiality of patient information was ensured throughout the study. Sample size was calculated using the WHO formula for a single population proportion, assuming a 95% confidence level (Z=1.96), an expected prevalence of 50%, and a 9.5% margin of error, yielding a minimum sample of 106 participants. To compensate for incomplete data, 109 children were enrolled using non-probability consecutive sampling. All eligible children presenting to the outpatient department or admitted to the pediatric ward with suspected urinary tract infection (UTI) were included consecutively. Since this was an observational cross-sectional study, no randomization or blinding was performed. Children aged 1 month to 12 years with symptoms suggestive of UTI, including fever, dysuria, urinary frequency, abdominal pain, vomiting, irritability, or poor feeding, were included. Both first-episode and recurrent suspected UTI cases were enrolled. Exclusion criteria included recent antibiotic use within 48-72 hours, congenital urinary tract abnormalities, chronic kidney disease, severe malnutrition, immunodeficiency, immunosuppressive therapy, and incomplete clinical or laboratory data. Data were collected through a structured proforma documenting demographic information, presenting symptoms, previous UTI history, urine microscopy findings, nitrite test results, culture findings, bacterial isolates, and antimicrobial susceptibility patterns. UTI diagnosis was based on compatible clinical features supported by urine microscopy and significant bacterial growth on culture. Significant bacteriuria was defined as $\geq 10^5$ CFU/mL for clean-catch specimens and $\geq 5 \times 10^4$ CFU/mL for catheterized samples with pyuria and symptoms. Contaminated samples with mixed growth were excluded from organism-specific analysis. Urine samples were collected before antibiotic administration using midstream clean-catch or catheterization techniques, depending on the child's age and toileting status. Samples were processed within two hours in the microbiology laboratory. Routine microscopy assessed pyuria and hematuria, while cultures were performed on standard media under aerobic conditions. Organisms were identified using Gram staining and biochemical tests. Antimicrobial susceptibility testing was conducted using the Kirby–Bauer disc diffusion method according to Clinical and Laboratory Standards Institute guidelines. Data were analyzed using IBM SPSS version 25. Quantitative variables were summarized as mean ± SD, while categorical variables were presented as frequencies and percentages. Chi-square or Fisher-Freeman-Halton exact tests, Cramer's V, and binary logistic regression were applied, with $p \leq 0.05$ considered statistically significant.

RESULTS

The study included 109 children with suspected urinary tract infection. The mean age was 6.72 ± 3.43 years, ranging from 1 to 12 years. Most children were in the 6–10 years age group, and 67 (61.5%) were female, compared to 42 (38.5%) male. Among the clinical features, Abdominal pain (57 (52.3%) was the most

frequent clinical feature, followed by dysuria 54 (49.5%), fever 53 (48.6%), and a previous history of UTI 52 (47.7%). Non-specific symptoms such as poor feeding and irritability were also commonly observed. The Laboratory findings showed that Pyuria was present in 63 (57.8%) and hematuria in 49 (45.0%) children, while nitrite positivity was found in 45 (41.3%). Urine culture was positive in 53 of 109 children, giving a culture positivity rate of 48.6% (95% CI: 39.4-57.9%).

Table 1: Distribution of Bacterial Isolates among Culture-Positive Cases, n = 53

Organism	Frequency n (%)
Staphylococcus spp.	11 (20.8%)
Enterococcus spp.	10 (18.9%)
Proteus spp.	09 (17.0%)
Escherichia coli	08 (15.1%)
Klebsiella spp.	08 (15.1%)
Pseudomonas spp.	07 (13.2%)
Total	53 (100.0%)

Table 2: Antibiotic Susceptibility Pattern among Culture-Positive Isolates, n = 53

Antibiotic	Sensitive n (%)	Resistant n (%)
Amoxicillin	22 (41.5%)	31 (58.5%)
Co-amoxiclav	22 (41.5%)	31 (58.5%)
Cefixime	30 (56.6%)	23 (43.4%)
Ceftriaxone	26 (49.1%)	27 (50.9%)
Ciprofloxacin	23 (43.4%)	30 (56.6%)
Nitrofurantoin	26 (49.1%)	27 (50.9%)
Gentamicin	26 (49.1%)	27 (50.9%)
Imipenem	27 (50.9%)	26 (49.1%)

Table 3: Association between Bacterial Isolate and Gender among Culture-Positive Cases, n = 53

Organism	Female n (%)	Male n (%)
Escherichia coli	06 (75.0%)	02 (25.0%)
Enterococcus spp.	06 (60.0%)	04 (40.0%)
Klebsiella spp.	06 (75.0%)	02 (25.0%)
Proteus spp.	05 (55.6%)	04 (44.4%)
Pseudomonas spp.	03 (42.9%)	04 (57.1%)
Staphylococcus spp.	07 (63.6%)	04 (36.4%)

Note: Pearson Chi-square showed no significant association between bacterial isolate and gender, χ^2 = 2.430, p = 0.787. Because 75.0% of expected cell counts were below 5, the Fisher-Freeman-Halton exact test was also applied and remained non-significant (p = 0.822). Cramer's V was 0.214, suggesting a weak association.

Table 4: Association between Culture Result and Pyuria, n = 109

Culture Result	Pyuria Absent n (%)	Pyuria Present n (%)
Negative	22 (39.3%)	34 (60.7%)
Positive	24 (45.3%)	29 (54.7%)

Note: Pearson Chi-square test was applied. No significant association was observed between pyuria and urine culture result, χ^2 = 0.402, p = 0.526. Cramer's V = 0.061 indicates a very weak association.

Table 5: Binary Logistic Regression for Predictors of Culture Positivity, n = 109

Variable	B	Adjusted OR	95% CI for OR	P-value
Age	-0.052	0.950	0.844-1.068	0.390
Gender	0.064	1.066	0.449-2.532	0.884
Fever	-0.165	0.848	0.383-1.879	0.685
Dysuria	-0.472	0.624	0.288-1.349	0.230
Increased urinary frequency	0.103	1.109	0.497-2.476	0.801
Abdominal pain	-0.004	0.996	0.458-2.168	0.992
Vomiting	-0.253	0.776	0.348-1.731	0.536
Previous UTI	0.457	1.579	0.708-3.523	0.264
Pyuria	0.215	0.806	0.355 1.831	0.607
Nitrite positive	-0.111	0.895	0.399-2.005	0.787

Note: Omnibus χ^2 = 4.491, df = 10, p = 0.923; Nagelkerke R^2 = 0.054; Hosmer–Lemeshow χ^2 = 10.492, p = 0.232; overall classification accuracy = 57.8%. AOR = adjusted odds ratio; CI = confidence interval. Culture positivity was coded as the outcome variable. The model included age, gender, fever, dysuria, urinary frequency, abdominal pain, vomiting, previous UTI, pyuria, and nitrite test result.

Table 6: Antibiotic Resistance Pattern by Bacterial Isolate among Culture-Positive Cases, n = 53

Organism	n	Amoxicillin R	Co-amoxiclav R	Cefixime R	Ceftriaxone R	Ciprofloxacin R	Nitrofurantoin R	Gentamicin R	Imipenem R
Escherichia coli	08	04(50.0) %	04(50.0) %	03(37.5%)	05(62.5%)	0337.5%)	04(50.0%)	02(25.0%)	06(75.0%)
Enterococcus spp.	10	0660.0%)	05(50.0%)	05(50.0%)	07(70.0%)	06(60.0%)	01(10.0%)	04(40.0%)	08(80.0%)
*Klebsiella*spp.	08	0450.0%)	05(62.5%)	02(25.0%)	03(37.5%)	05(62.5%)	03(37.5%)	03(37.5%)	03(37.5%)
*Proteus*spp.	09	07(77.8%)	03(33.3%)	05(55.6%)	04(44.4%)	07(77.8%)	07(77.8%)	04(44.4%)	04(44.4%)
*Pseudomonas*spp.	07	04(57.1%)	05(71.4%)	04(57.1%)	04(57.1%)	03(42.9%)	04(57.1%)	05(71.4%)	01(14.3%)
*Staphylococcus*spp.	11	06 (54.5%)	09 (81.8%)	04 (36.4%)	04 (36.4%)	06 (54.5%)	08 (72.7%)	09 (81.8%)	04 (36.4%)

Note: R = resistant. Percentages are calculated within each organism group. Because the number of isolates in each organism group was small, organism-wise resistance patterns should be interpreted descriptively and cautiously.

DISCUSSION

Urinary tract infection (UTI) remains one of the most common bacterial infections in children and is associated with considerable morbidity when diagnosis and treatment are delayed. In the present study, the mean age of participants was 6.72 ± 3.43 years, with the majority in the 6–10 years age group, and females constituted 61.5% of the study population. These

findings are consistent with the established epidemiological pattern of pediatric UTI, where girls are more frequently affected after infancy because of anatomical factors such as a shorter urethra and closer proximity of the urethral opening to the perineum.[14,15] However, because this was a hospital-based study employing consecutive sampling, the observed demographic distribution should be interpreted as representative of children presenting to a tertiary-care pediatric department rather than the true community prevalence of pediatric UTI. The clinical manifestations observed in this study included abdominal pain, dysuria, fever, urinary frequency, vomiting, irritability, and poor feeding, highlighting the well-recognized variability in pediatric UTI presentation. Older children commonly present with urinary complaints such as dysuria and frequency, whereas infants and younger children often exhibit non-specific symptoms including fever, vomiting, irritability, and poor feeding.[16,17] This overlap in clinical presentation emphasizes the importance of microbiological confirmation, as reliance on symptoms alone may overestimate the actual prevalence of UTI. In the present study, urine culture was positive in 53 of 109 clinically suspected cases, resulting in a culture positivity rate of 48.6% (95% CI: 39.4%-57.9%). Therefore, the findings should be interpreted as bacteriological characteristics among culture-confirmed cases rather than among all clinically suspected pediatric UTIs. The bacteriological profile differed from the conventional pattern described in most pediatric UTI literature, where Escherichia coli accounts for approximately 80–90% of infections.[18,19] Among the 53 culture-positive cases, Staphylococcus spp. was the most frequent isolate, accounting for 11 cases (20.8%; 95% CI: 12.0%-33.5%), followed by Enterococcus spp. (18.9%), Proteus spp. (17.0%), Escherichia coli (15.1%), Klebsiella spp. (15.1%), and Pseudomonas spp. (13.2%). Nevertheless, these findings should not be interpreted as evidence of a changing global epidemiological trend in pediatric UTI, where E. coli remains the predominant uropathogen. Instead, the observed organism distribution may reflect local hospital-based sampling, recurrent infections, previous antibiotic exposure, catheter-collected specimens, or possible contamination. The predominance of Staphylococcus spp. particularly warrants cautious interpretation because certain staphylococcal species, such as Staphylococcus saprophyticus, may represent true uropathogens, whereas coagulase-negative staphylococci can also indicate contamination if collection technique, pyuria, colony count, and clinical correlation are not adequately assessed.[20] Although contaminated samples with mixed growth or insignificant colony counts were excluded, species-level confirmation of all staphylococcal isolates was unavailable. Another important consideration is catheter-associated infection. Catheterized urine specimens are frequently required in infants and non-toilet-trained children to minimize contamination compared with bag urine collection.[21] However, hospitalized or catheter-exposed children may exhibit a different microbiological profile compared with uncomplicated community-acquired UTI. Organisms such as Enterococcus spp., Pseudomonas spp., and staphylococcal isolates are more commonly associated with recurrent, catheter-associated, complicated, or hospital-acquired infections.[22] Since the present study did not fully stratify cases according to hospitalization status, catheter exposure, or community- versus hospital-acquired infection, the bacteriological findings should be interpreted descriptively and cautiously. The antimicrobial susceptibility pattern demonstrated moderate sensitivity to several antibiotics. Cefixime showed the highest sensitivity among culture-positive isolates, whereas amoxicillin and co-amoxiclav demonstrated the highest resistance rates. Similar resistance trends among pediatric uropathogens have been documented in recent regional and international studies.[23,24] Organism-specific analysis further revealed higher resistance of Proteus spp. to amoxicillin, ciprofloxacin, and nitrofurantoin, while Staphylococcus spp. demonstrated increased resistance to co-amoxiclav and gentamicin. These observations underscore the clinical importance of organism-specific susceptibility reporting rather than relying solely on overall sensitivity percentages. However, because each bacterial group contained relatively few isolates, these findings should be regarded as descriptive rather than definitive. Imipenem resistance deserves particular attention. Resistance was observed in 26 of 53 isolates (49.1%), suggesting hospital exposure, complicated infection, prior antibiotic use, or the presence of multidrug-resistant organisms.[6,25] Nevertheless, the absence of MIC testing, MDR classification, molecular resistance analysis, and infection stratification limits definitive interpretation. Statistical analysis further demonstrated no significant association between bacterial isolate and gender, with Fisher-Freeman-Halton exact testing remaining non-significant and Cramer's V indicating only a weak association (0.214). Similarly, pyuria was not significantly associated with culture positivity, suggesting that urine microscopy alone may not reliably differentiate culture-confirmed UTI cases. Binary logistic regression also failed to identify any independent predictor of culture positivity among assessed clinical and laboratory variables. Overall, these findings reinforce the importance of urine culture, contamination control, and regular antimicrobial surveillance in guiding empirical therapy for pediatric UTIs.

LIMITATIONS

Outpatient and inpatient cases, first-episode and recurrent UTIs, catheterized and clean-catch samples, and community- versus hospital-acquired infections were not analyzed separately. Furthermore, species-level confirmation of all staphylococcal isolates, MIC-based susceptibility testing, MDR classification, and molecular resistance analysis were unavailable. Severely malnourished and immunocompromised children were also excluded, limiting applicability to high-risk pediatric populations.

CONCLUSIONS

Nearly half of clinically suspected pediatric UTI cases were culture positive. Staphylococcus spp. was the most frequent isolate, followed by Enterococcus spp., Proteus spp., Escherichia coli, Klebsiella spp., and Pseudomonas spp.; however, the predominance of Staphylococcus spp. should be interpreted cautiously because species-level confirmation and detailed contamination assessment were limited. Antibiotic resistance patterns varied among organisms, while imipenem resistance was reported descriptively due to the absence of MIC testing, MDR classification, and hospital-acquired infection stratification. These findings emphasize the importance of routine urine culture, cautious interpretation of gram-positive isolates, reporting of organism-specific susceptibilities, and regular local antimicrobial surveillance to guide empirical treatment of pediatric UTI.

CONFLICT OF INTEREST: None

FUNDING SOURCES: None

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The authors accept responsibility for all aspects of the work and will ensure that any concerns regarding the accuracy or integrity of any part are properly investigated and resolved.