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Clinical Profile and Bacteriological Patterns of Urinary Tract Infections in Hospitalized Pediatric Patients at Ngoerah Hospital

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Abstract

Urinary tract infection (UTI) is a common bacterial infection in children, particularly among infants, and may lead to complications such as renal scarring and hypertension. Clinical manifestations vary according to age, with infants often presenting with nonspecific symptoms, while Escherichia coli is the most frequently identified pathogen, followed by other Gram-negative organisms. However, local data regarding bacterial patterns and clinical manifestations of pediatric UTIs at Ngoerah Hospital remain limited. This descriptive study aimed to characterize bacterial patterns and clinical features among children with UTIs who were hospitalized at Ngoerah Hospital from 2020 to 2025 using medical record data to strengthen local epidemiological evidence. A minimum of 100 patients was selected through consecutive sampling based on sample size calculations for descriptive categorical studies. Data were extracted from medical records, analyzed using SPSS version 20, and presented as frequency and percentage distributions. Among the 100 children with UTIs hospitalized at Ngoerah Hospital between 2020 and 2025, the highest proportion of cases occurred in the >5-year age group (51%), with a relatively balanced sex distribution. The most common clinical manifestation was fever (73%), followed by dysuria (18%). The bacterial etiology was predominantly composed of Gram-negative organisms, with Escherichia coli (38%) and Klebsiella pneumoniae (21%) identified as the most common pathogens, followed by Pseudomonas aeruginosa (12%), Proteus mirabilis (7%), and Enterococcus faecalis (4%). Overall, pediatric UTIs at Ngoerah Hospital between 2020 and 2025 were most frequently observed among children aged >5 years and commonly presented with fever, with Escherichia coli identified as the predominant causative organism.

INTRODUCTION

Urinary tract infection (UTI) is one of the most common bacterial infections in the pediatric population, particularly among infants, and has significant clinical implications for child health (Marsh et al., 2024; Maringhini et al., 2024). In the short term, UTIs can cause substantial morbidity, and recurrent infections may contribute to long-term complications, such as renal scarring, hypertension, and progression to end-stage chronic kidney disease (Maringhini et al., 2024; Alsaywid et al., 2023). Additionally, UTIs represent an important cause of increased pediatric healthcare visits, including outpatient consultations and emergency department admissions (Ara et al., 2023; Lu et al., 2022).

The clinical manifestations of UTIs vary according to age group (Marsh et al., 2024; Maringhini et al., 2024). Diagnosis in infants is often challenging because the presenting symptoms are nonspecific, with fever sometimes being the only clinical sign (Maringhini et al., 2024). In contrast, older children more commonly present with characteristic symptoms, such as dysuria, increased urinary frequency, urgency, and suprapubic pain, which are more readily recognized and facilitate diagnosis (Maringhini et al., 2024; Alsaywid et al., 2023). Research by Priya et al. (2025) demonstrated that fever was the most common symptom across all age groups, whereas symptoms such as abdominal pain, dysuria, urgency, and frequency were more frequently observed in children older than 5 years. Similarly, Kutty et al. (2025) reported that fever occurred in 90.3% of pediatric UTI cases, while dysuria was reported in 26.88% of cases.

Globally, Escherichia coli remains the leading causative pathogen of UTIs in children, consistently accounting for approximately 50–60% of cases across epidemiological studies (Masar et al., 2023; Bari'ah et al., 2025). However, the distribution of causative bacteria may vary across regions and age groups. A study conducted at Dr. Soetomo Hospital, Surabaya (2020–2023), found that Escherichia coli (31.8%), Pseudomonas aeruginosa (16.9%), and Klebsiella pneumoniae (12.3%) were the most common pathogens among pediatric urology patients (Alsaywid et al., 2023). Meanwhile, a study at RSUP Dr. M. Djamil Padang (2017–2021) reported a different bacterial distribution pattern, with Klebsiella pneumoniae as the predominant pathogen among male patients (37.9%) and Escherichia coli among female patients (87%) (Bari'ah et al., 2025). Research by Mandal et al. (2024) in India reported Escherichia coli as the most common causative organism (45%), followed by Klebsiella species (22%) and Enterococcus species (13%) among children aged 6 months to 5 years. These variations in bacterial patterns highlight the importance of local epidemiological data to support appropriate empirical therapy (Kruis et al., 2020; Muteeb, 2023; Namikawa et al., 2025).

Despite the well-established global trend, comprehensive local data describing the prevalence and characteristics of UTIs among pediatric patients at Ngoerah Hospital remain limited. The absence of complete institutional data represents an important research gap, restricting understanding of local pathogen distribution and potentially hindering evidence-based clinical decision-making tailored to the local population. Studies from various countries have demonstrated that antibiotic resistance patterns continue to evolve and represent a major clinical challenge (Lu et al., 2022; Kementerian Kesehatan Republik Indonesia, 2014). A systematic review in Indonesia reported that the susceptibility of Escherichia coli and Klebsiella pneumoniae to cephalosporins was frequently below 30%, whereas amikacin and meropenem maintained antimicrobial activity exceeding 90% (Kementerian Kesehatan Republik Indonesia, 2014). These findings emphasize the importance of continuous surveillance of local antimicrobial resistance patterns.

The urgency of this research lies in the need for local epidemiological data to support improved management of pediatric UTIs at Ngoerah Hospital. Without specific information regarding bacterial distribution and antimicrobial susceptibility patterns, empirical treatment may be ineffective, potentially increasing morbidity, length of hospital stay, and the risk of antimicrobial resistance (Maringhini et al., 2024; Lu et al., 2022). This research is particularly important given the dynamic changes in resistance patterns and differences in pathogen distribution across regions, making data from Ngoerah Hospital valuable for developing and refining local clinical practice guidelines.

The novelty of this research lies in providing comprehensive baseline data regarding the clinical profile and bacteriological patterns of pediatric UTIs at Ngoerah Hospital during the 2020–2025 period, which has not previously been published. Unlike studies from Surabaya that focused on pediatric urology patients (Alsaywid et al., 2023) or studies from Padang covering the 2017–2021 period (Bari'ah et al., 2025), this study provides a contemporary overview of the clinical and bacteriological characteristics of UTIs among a broader pediatric population at a tertiary hospital in Bali. Furthermore, this study evaluates bacterial distribution according to age and sex, as well as the antimicrobial susceptibility patterns of Escherichia coli, providing practical implications for clinical management.

Based on these considerations, this study aimed to identify the clinical profile and bacteriological patterns of UTIs among pediatric patients at Ngoerah Hospital during the 2020–2025 period. The specific objectives were to describe the distribution of patient characteristics (age, sex, nutritional status, urinalysis findings, and clinical manifestations), identify the spectrum of causative bacteria, and analyze bacterial distribution according to age and sex. The findings of this study are expected to contribute academic value by enriching local epidemiological data regarding bacterial pathogens causing pediatric UTIs and serving as a foundation for future research. Additionally, the results may provide practical implications for clinicians in selecting rational antimicrobial therapy based on local bacterial patterns.

METHOD

This study employed a retrospective descriptive design to map bacterial patterns among pediatric patients with urinary tract infections (UTIs) at Ngoerah Hospital using secondary data obtained from medical records for the period 2020–2025. The target population consisted of all pediatric patients with UTIs who were hospitalized at Ngoerah Hospital. Samples were selected using consecutive sampling until a minimum of 100 patients was achieved (calculated minimum sample size: n = 92). The inclusion criteria included pediatric patients diagnosed with UTIs, while patients with negative urine culture results were excluded. Data were obtained from the pediatric nephrology registry and cross-checked with physical and electronic medical records at Prof. Ngoerah Hospital. The sample size was calculated using the formula for descriptive categorical studies. The sample size was calculated based on the formula for descriptive categorical research questions:

$$n = \frac{Za2\ x\ p\ x\ q}{d2}$$

n = sample size

za = standard normal deviate for α = 1.96

p = estimated disease proportion[8] = 0.4

q = 1-p= 0,6

d = acceptable margin of error = 0.1

The sample size calculation yielded the following result:

$$\frac{1{,}962 \times 0{,}4 \times 0{,}6}{0.1^2}$$

n = The calculated sample size of 92 was rounded up to 100.

The operational definitions of the study variables are as follows:

1. Gender was determined based on phenotypic appearance. The variable was presented as categorical data: (1) female and (2) male.
2. Age was defined as the chronological age of the sample at the time of the study, calculated based on the date, month, and year of birth. The variable was presented as categorical data: (1) <1 year; (2) 1–5 years; and (3) >5 years.8
3. Nutritional status was determined by recording body weight and body length/height and interpreting these measurements according to the WHO Child Growth Standards 2006

growth charts. The variable was presented as categorical data: (1) malnutrition (mild, moderate, severe malnutrition, and overweight/obesity) and (2) normal nutritional status.9

4. Clinical manifestations were defined as the chief complaints and clinical symptoms reported by patients at the time of UTI diagnosis and recorded in the medical records. These were categorized into local and systemic symptoms. The variable was presented as categorical data: (1) yes and (2) no.10
5. Nitrite referred to the presence of nitrite on urinalysis as recorded from urine examination results at the time of diagnosis. The variable was presented as categorical data: (1) positive and (2) negative.10
6. Pyuria was defined as a leukocyte count >5 per high-power field (HPF) in urine, as recorded from urinalysis results at the time of diagnosis. The variable was presented as categorical data: (1) yes and (2) no.11
7. Hematuria was defined as an erythrocyte count >5 per high-power field (HPF) in urine, as recorded from urinalysis results at the time of diagnosis. The variable was presented as categorical data: (1) yes and (2) no.12

Data collection was performed through observation of medical records using secondary data obtained from Ngoerah Hospital, with measurement outcomes defined as the identification of specific bacterial organisms, measured on a nominal scale. Data were processed (editing, coding, entry, and cleaning) and analyzed using SPSS for Mac version 23.0. Results were presented as frequencies (%) for categorical variables and as distribution tables according to causative agents, sex, and age. This study got permission number 04.03/D.XVII.2.2.2/75522/2025 from Ethic Committee of Faculty of Medicine, University of Udayana/ Ngoerah Hospital. All research costs were borne by the investigator. Patient confidentiality was strictly maintained, and study results were used solely for scientific purposes.

RESULTS AND DISCUSSION

This study was conducted on 100 pediatric patients with urinary tract infections (UTIs) who were hospitalized at Ngoerah Hospital from 2020 to 2025. The processed data are presented as frequency distributions, illustrating the distribution of causative bacteria as well as bacterial distribution according to sex and age, as described below.

The results presented in Table 1 show that the largest proportion of respondents was in the > 5 year age group, comprising 51 patients (51%), while the smallest proportion was observed in the < 1 year age group, with 25 patients. Based on sex, the respondents consisted of 50 males (50%) and 50 females (50%), indicating a relatively balanced distribution. Urinalysis findings demonstrated that the majority of patients exhibited leukocyturia, observed in 27 children (27%), which was the most frequent finding and consistent with an ongoing urinary tract infection. The combination of leukocyturia and hematuria was identified in 21 children (21%), while the simultaneous presence of leukocyturia, hematuria, and nitrituria was found in 6 children (6%). Isolated hematuria was observed in only 5 children (5%), and isolated nitrituria was not detected. These findings indicate that most respondents exhibited laboratory features of UTIs, predominantly characterized by leukocyturia and hematuria.

Figure 1 shows that the most common symptom among respondents with UTIs was fever, which was observed in 73 patients (73%). Other relatively frequent symptoms included dysuria in 18 patients (18%). Less common manifestations included flank pain and enuresis (7%), and asymptomatic presentation (8%). Several symptoms were observed in only a small proportion of respondents, including urgency, vomiting, frequency, hematuria, failure to thrive and nausea. Overall, these data demonstrate that fever was the most dominant clinical manifestation of pediatric UTIs.

Table 1. Characteristics of Research Subjects

Variables	**n (%)**
Age Group, n (%)	
< 1 year	25 (25%)
1–5 years	34 (34%)
> 5 years	51 (51%)
Sex n (%)	
Boy	50 (100)
Girl	50 (100)
Urinalysis Findings, n (%)	
Leukosituria	27 (27)
Hematuria	5 (5)
Nitrituria	0 (0)
Leukosituria, Hematuria	21 (21)
Leukosituria, Nitrituria	8 (8)
Hematuria, Nitrituria	2 (2)
Leukosituria, Hematuria, Nitrituria	6 (6)
Nutritional Status, n (%)	
Well Nourished	48 (48)
Mild Protein Energy Malnutrition	18 (18)
Moderate Protein Energy Malnutrition	13(13)
Severe Protein Energy Malnutrition	15 (15)
Possible risk of overweight	2 (2)
Overweight	2 (2)
Obesity	2 (2)
Total	100 (100%)

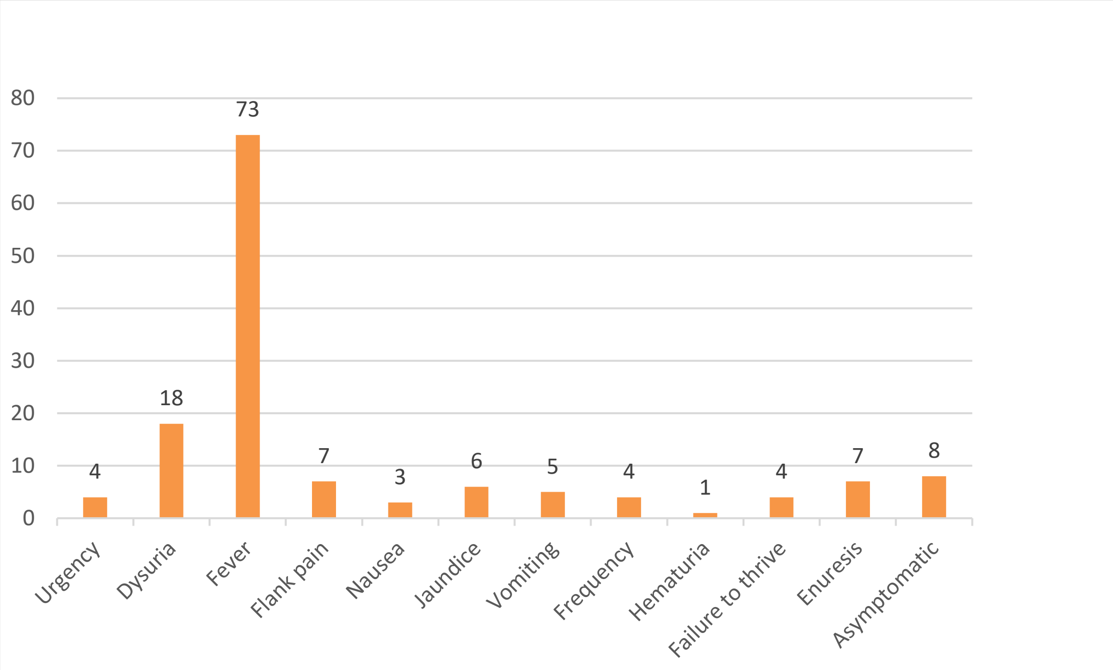
Source: Prepared by the authors based on the research schedule conducted at PT Pertamina Hulu Indonesia Regional 3 Zone 9 Sangatta Field (2025).

Table 2. Age Group Characteristics of Respondents by Sex

Age Group	**Boy**		**Girl**	
	n	%	n	%
< 1 year	14	50	14	50
1– 5 year	20	58.8	14	41
>5 year	15	40.5	22	59.5%

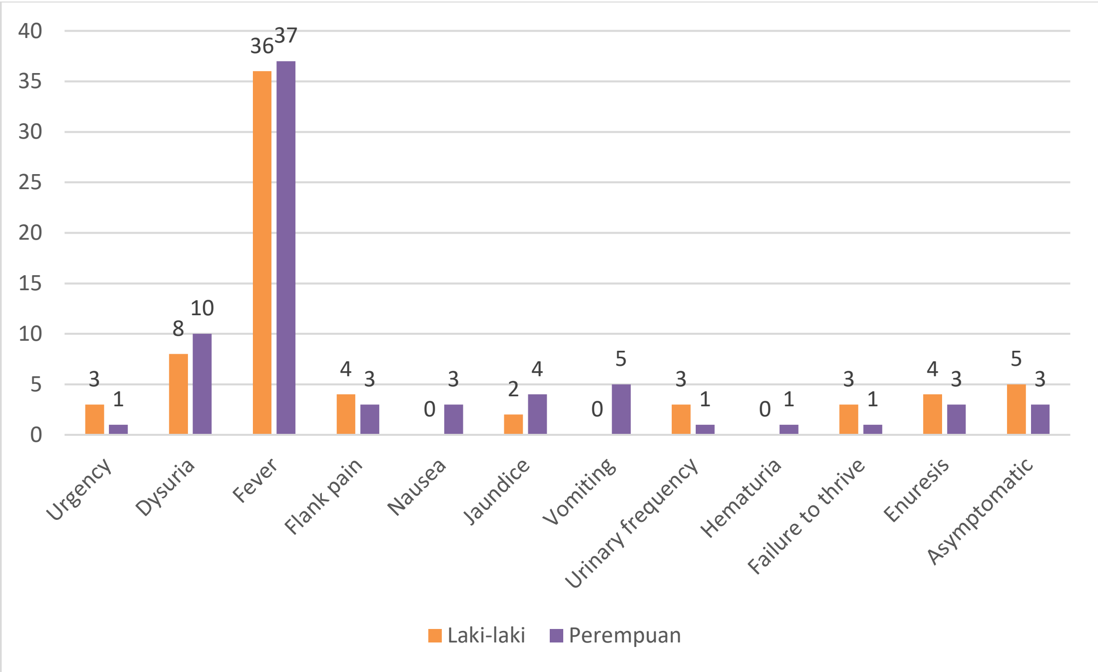
Source: Prepared by the authors based on production, completion, and reservoir data from PT Pertamina Hulu Indonesia Regional 3 Zone 9 Sangatta Field (2025).

Figure 1. Characteristics of Urinary Tract Infection Symptoms



Source: PT Pertamina Hulu Indonesia Regional 3 Zone 9 Sangatta Field, Production History Data (2025).

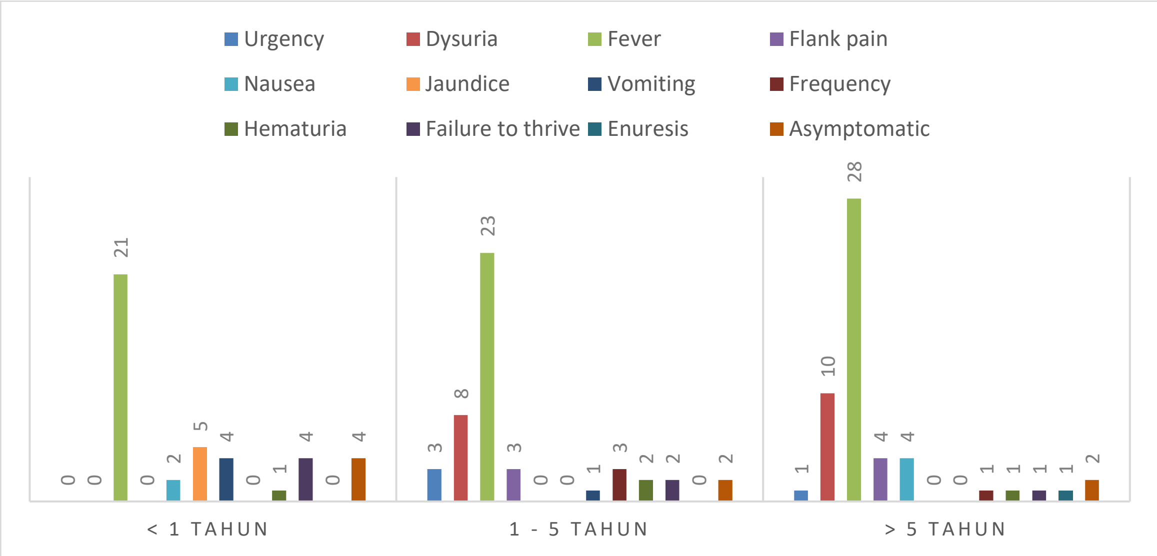
Figure 2. Characteristics of UTI Symptoms According to Sex



Source: Prepared by the authors based on production and reservoir pressure data from PT Pertamina Hulu Indonesia Regional 3 Zone 9 Sangatta Field (2025).

Based on Figure 2, the distribution of UTI-related symptoms differed between male and female respondents. Fever was the most common symptom in both sexes (36 males and 37 females). The second relatively frequent symptom was dysuria, which was more commonly observed in females. Symptoms such as nausea, vomiting, urinary of Frequency, enuresis, and hematuria were identified in only a small proportion of cases. Overall, fever and dysuria were the dominant clinical manifestations of pediatric urinary tract infections in female and male.

Figure 3. Characteristics of UTI Symptoms According to Age



Source: Prepared by the authors based on injection pressure and cumulative injection data from PT Pertamina Hulu Indonesia Regional 3 Zone 9 Sangatta Field (2025).

From the results of this study, in the <1–year–old group, the most common symptoms were systemic symptoms such as fever (21%), and jaundice (5%). The predominant symptom in the 1–5 years old group was fever (23%), while local symptoms were dysuria (8%), and nausea, urgency, frequency (2%). In the >5 years old group, systemic symptoms predominate also with fever (28%) and local symptoms showed dysuria (10%), and flank pain dan nausea (4%).

Table 3. Characteristics of Bacterial Etiology of Urinary Tract Infection

Spesies	**n**	**%**
Gram-positive bacteria	6	6
Enterococcus faecium	4	4
Enterococcus faecalis	1	1
Methicillin Resistant Staphylococcus aureus	1	1
Gram-negative bacteria	94	94
Escherichia coli	38	38
Klebsiella pneumoniae	21	21
Pseudomonas aeruginosa	12	12
Proteus mirabilis	7	7
Enterobacter cloacae	5	5
Burkholedria cepacia	2	2
Acinetobacter baumannii	1	1
Citrobacter koseri	1	1

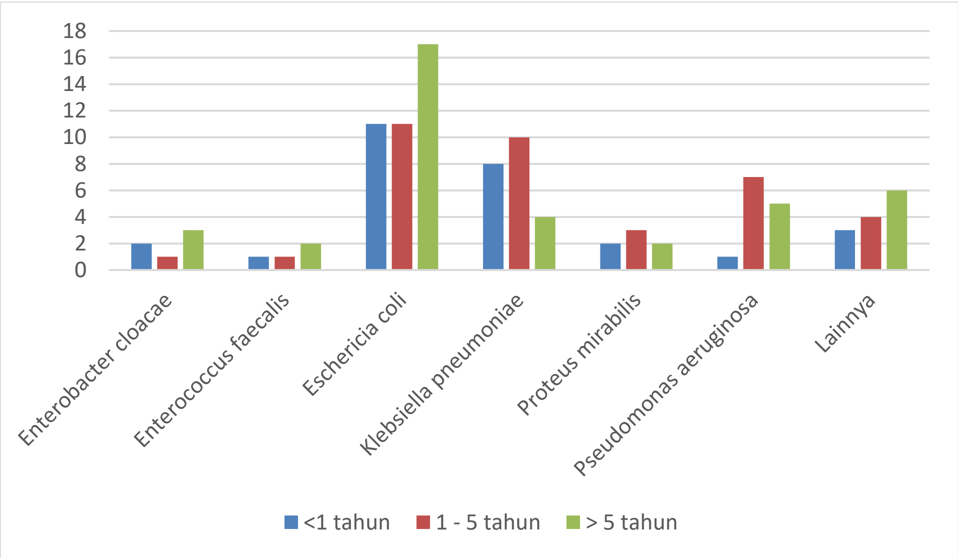
Spesies	n	%
Klebsiella oxytoca	1	1
Morganela morganii	1	1
Pantoea spp.	1	1
Proteus hauseri	1	1
Salmonella spp.	1	1
Achromobacter xylosoxidans	1	1
Acinetobacter baumannii	1	1
Total	100	100.00

Source: Prepared by the authors based on injection and production data from PT Pertamina Hulu Indonesia Regional 3 Zone 9 Sangatta Field (2025).

The study results demonstrated that the distribution of UTI-causing bacteria varied across age groups. Gram-negative bacteria were found to predominate in the results of this study. *Escherichia coli* was the most dominant organism identified in all age groups, with a total of 38 isolates (38%), *Klebsiella pneumoniae* ranked second, with 21 isolates (21%), *Pseudomonas aeruginosa* was identified in 12 isolates, most commonly in the 1–5-year age group (6%). *Proteus mirabilis* was detected in 7 isolates, with the highest distribution in children aged 1–5 years (3%). *Enterobacter cloacae* was identified in 5 isolates, predominantly in children older than 5 years (5%).

Several other bacterial species were detected at low frequencies (1%), including *Enterococcus faecalis, Citrobacter koseri, Klebsiella oxytoca, Morganella morganii, Acinetobacter baumannii, methicillin-resistant Staphylococcus aureus (MRSA), Pantoea spp., Salmonella spp.*, and *Sphingomonas paucimobilis*. Overall, these findings confirm that *E. coli* and *Klebsiella pneumoniae* remain the primary causative agents of pediatric UTIs across all age groups, whereas other bacteria play only a minor etiological role with low prevalence.

Figure 4. Distribution of Bacterial Etiology of Urinary Tract Infections According to Age



Source: Prepared by the authors based on production and injection data analyzed using the Thakur method, PT Pertamina Hulu Indonesia Regional 3 Zone 9 Sangatta Field (2025).

Table 4. Distribution of Bacterial Etiology of Urinary Tract Infections According to Sex

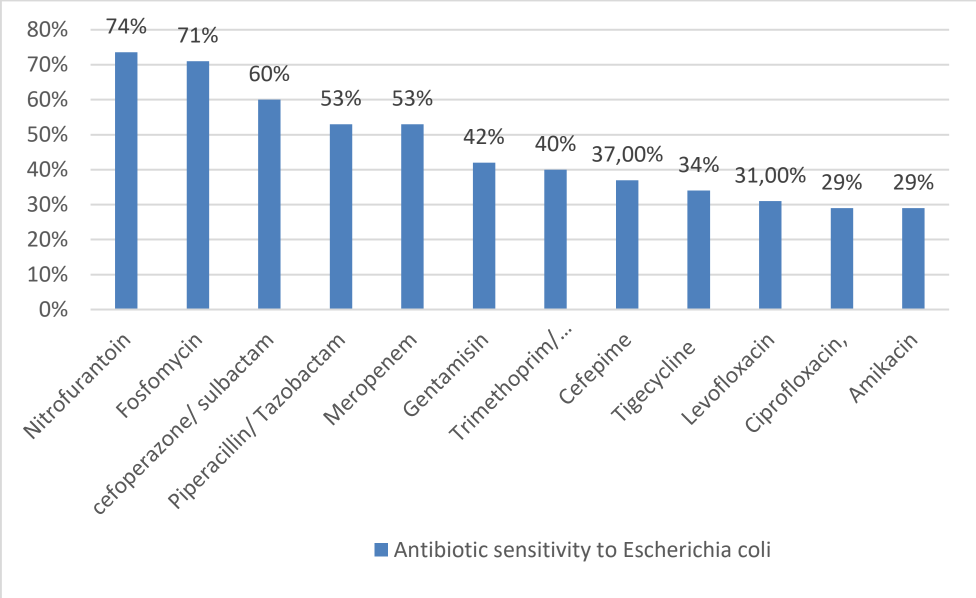
Bactery		**Sex**		**Total**
		Boy	Girl	
Escherichia coli	n	13	25	38
	%	13	25	38
Klebsiella pneumonia	n	14	7	21
	%	14	7	21
Lainnya	n	5	8	13
	%	5	8	13
Pseudomonas aeruginosa	n	7	5	12
	%	7	5	12
Proteus Mirabilis	n	6	1	7
	%	6	1	7
Enterobacter cloacae	n	3	2	5
	%	3	2	5
Enterococcus faecalis	n	2	2	4
	%	2	2	4
Total	F	50	50	100
	%	50	50	100

Source: Prepared by the authors based on IPR, Hall Plot, Production Plot, and Chan Plot analyses using field data from PT Pertamina Hulu Indonesia Regional 3 Zone 9 Sangatta Field (2025).

Based on the bacterial distribution by sex shown in Table 4, the most frequently isolated species was Escherichia coli, with 38 isolates (38%), occurring more often in females (25%) than in males (13%). The second most common species was Klebsiella pneumoniae, with 21 isolates (21%), which was more frequently identified in males (14%) than in females (7%). Pseudomonas aeruginosa was also detected in 12 isolates (12%) and was more predominant in males (7%) than in females (5%). Proteus mirabilis was identified in 7 isolates (7%) and was predominantly found in male patients.

Overall, the distribution pattern indicates that UTIs were more common in females, with a predominance of E. coli, whereas male patients exhibited a more diverse bacterial spectrum, particularly Klebsiella pneumoniae and Proteus mirabilis.

Figure 5. Antibiotic sensitivity pattern of Eschericia Coli



Source: Prepared by the authors based on Water-Oil Ratio (WOR) analysis using production data from PT Pertamina Hulu Indonesia Regional 3 Zone 9 Sangatta Field (2025).

In this study, Escherichia coli isolates demonstrated varying degrees of susceptibility to parenteral agents, with the highest sensitivity observed for cefoperazone–sulbactam (60%), followed by meropenem and piperacillin–tazobactam (each 53%), gentamicin (42%), cefepime (37%), tigecycline (31%), levofloxacin (31%), and amikacin (29%). In contrast, a high rate of resistance to ampicillin was identified (65%). Regarding oral antibiotics, E. coli showed preserved susceptibility to nitrofurantoin (74%) and fosfomycin (71%), whereas sensitivity to trimethoprim–sulfamethoxazole was considerably lower (40%).

Highest proportion of cases of UTIs occurred in the >5-year age group, accounting for 51% of cases. The relatively high incidence in this age group may be associated with hormonal changes during puberty, personal hygiene practices, and behavioral factors such as habitual postponement of urination, which are commonly observed among adolescents (Soemyarso et al., 2018).

The sex distribution showed a relatively balanced proportion, with 50% males and 50% females, particularly among children younger than 1 year. A contemporary meta-analysis concluded that UTIs are relatively common during the first year of life and that, during this period, UTIs occur with similar frequency in male and female infants. After the first year of life, however, the incidence tends to be higher in females (Renko et al., 2022).

In contrast, UTIs were more frequent among females in children older than 5 years. Females are generally more susceptible to UTIs due to anatomical factors, including a shorter urethra and its close proximity to the anus (Kim & Park, 2023). Although no studies have specifically addressed this age group, a cohort study conducted in 2020 reported a higher overall incidence of UTIs in females compared with males across the 0–17-year age range (2.48 vs. 0.18 per 100 patient-years) (Liang et al., 2024).

A study by Bhuiyan et al. in Shaheed Syed Nazrul Islam Hospital, Bangladesh, found a higher prevalence of malnutrition among pediatric patients with UTIs compared with those with normal nutritional status. A retrospective study conducted in Padang evaluating the clinical and bacteriological profiles of pediatric UTIs at RSUP Dr. M. Djamil Padang (2017–2021) reported a higher incidence of UTIs among malnourished children (56.8%) compared with well-nourished subjects (34.6%), concluding that malnourished children had a higher risk of developing UTIs (Bari'ah et al., 2025). In contrast, previous studies from India reported no significant association between UTI prevalence and malnutrition (Reginawati et al., 2023). In the present study, the majority of pediatric patients with UTIs had normal nutritional status.

From the urinalysis, hematuria and leukocyturia >5/hpf can occur in UTIs (Ikatan Dokter Anak Indonesia, 2011; Leslie et al., 2025). A study form Balighian, et al. concluded that urinalysis results showed that most respondents show leukocyturia (27%), a key indicator of UTIs reflecting bacterial colonization and the resulting inflammatory response within the urinary tract. The sensitivity of leukocyturia for diagnosing UTIs in children on urinalysis has a relatively high sensitivity (approximately 83–87%) and is useful for excluding UTIs (sensitivity up to 88%), although quantitative urine culture with significant bacterial growth (≥50,000 colonies/mL) remains the diagnostic gold standard for UTIs in children aged 2–24 months (Lee et al., 2024). Additionally, erythrocyturia was observed in 34% of respondents, suggesting mucosal irritation or inflammation of the urinary tract due to infection (Umboh & Umboh, 2016). Nitrituria (16%) indicated the presence of nitrate-reducing bacteria, most commonly Enterobacteriaceae such as Escherichia coli (Fisher & Steele, 2024). A study conducted by Sultana et al. showed that the urinary nitrite test had a sensitivity of 75.56% and a specificity of 97.00%, with an overall accuracy of 90.34%. The positive predictive value (PPV) was 91.89% and the negative predictive value (NPV) was 89.81% for diagnosing urinary tract infections in children (Sultana et al., 2024).

The predominance of bacteriuria and leukocyturia in this study reinforces that the majority of respondents indeed had UTIs. The presence of erythrocyturia and nitrituria in some patients further highlights the variability of clinical manifestations and their potential role as additional diagnostic indicators. These findings are consistent with previous studies reporting that the combination of bacteriuria, leukocyturia, and nitrituria constitutes an important set of laboratory parameters for UTI diagnosis (Fisher & Steele, 2024).

The study findings indicate that fever was the most dominant symptom among children with UTIs (73%). In infants younger than 1 year, fever often represented the primary or even the sole manifestation of UTI. Notably, compared with other age groups, growth failure (4%) and jaundice (6%) were reported in a subset of cases. These manifestations may reflect systemic effects of infection or metabolic disturbances associated with renal involvement (Yang et al., 2024). These results are consistent with an observational study from Poland involving 948 children, which reported that among infants younger than 12 months, fever was the main symptom (63.4%), while only 16.3% exhibited urinary tract–specific symptoms (Daniel et al., 2023). UTIs often present as fever without an obvious infectious focus, complicating early diagnosis. Persistent fever is frequently the main reason caregivers seek medical attention, underscoring its importance as an early clinical warning sign (Daniel et al., 2023). Because UTIs in infants and young children are often nonspecific and become more characteristic with increasing age, UTIs should be suspected in any febrile infant until alternative diagnoses are confirmed, given the risk of complications such as urosepsis and renal scarring (Kaufman et al., 2019).

With increasing age, the clinical manifestations of UTIs shift from nonspecific symptoms to more characteristic urinary tract symptoms. Fever remains the predominant manifestation in children aged 1–5 years; however, classic urinary symptoms such as dysuria, urgency, and pollakiuria begin to appear, reflecting the child's improved ability to recognize and communicate discomfort during urination as well as maturation of the nervous system regulating bladder sensation. In children older than 5 years, UTI symptoms become increasingly specific, with higher frequencies of dysuria, suprapubic pain, and flank pain, suggesting upper urinary tract involvement (pyelonephritis). Older children can generally verbalize their complaints, facilitating clinical diagnosis compared with infants. Several studies support this pattern. Maringhini et al. reported that among 948 children with UTIs, fever was present in 63.4%, while classic symptoms such as dysuria and flank pain increased significantly in children older than 5 years compared with those younger than 1 year (Maringhini et al., 2024). Chen et al., in a Frontiers in Pediatrics study, also found that dysuria and frequency most commonly appeared after 3 years of age and were positively correlated with E. coli culture positivity (Lu et al., 2022). Kliegman et al. noted that in school-aged children, classic symptoms such as urgency, frequency, and flank pain become the primary diagnostic indicators, replacing the nonspecific symptoms commonly seen in infants and toddlers (Kliegman et al., 2023). In addition to neurological and communication development, the increased prevalence of characteristic symptoms in older children may also reflect a shift in infection patterns, with lower UTIs (cystitis) being more common in school-aged children and upper UTIs (pyelonephritis) predominating in infants (Pietropaolo et al., 2025).

Interestingly, this study also identified asymptomatic cases (8%), highlighting that pediatric UTIs may occur without typical symptoms and be detected only through laboratory testing. This has important clinical implications, as asymptomatic UTIs may still lead to serious complications such as pyelonephritis or renal damage if not diagnosed early, although precise quantification of the increased risk remains unclear due to limited available data (Pietropaolo et al., 2025).

The results shown in Table 3 demonstrate that the distribution of UTI-causing bacteria varied by age group; however, Escherichia coli remained the dominant pathogen (38%). This finding is consistent with international studies reporting that E. coli accounts for 70–90% of pediatric UTI cases (Umboh & Umboh, 2016; Kliegman et al., 2023). The high prevalence of E. coli across all age groups may be explained by its ability to colonize the perineum and ascend the urinary tract via the urethra. Virulence factors such as type 1 pili, P fimbriae, and biofilm formation enable uropathogenic E. coli (UPEC) to effectively cause infection in children (Zhou et al., 2023).

The results depicted in Figure 3 show differences in bacterial distribution between males and females. Overall, E. coli remained the most prevalent species (38%), with a higher prevalence in females (25%) than in males (13%). This aligns with existing literature indicating that females are more susceptible to UTIs due to anatomical factors, including a shorter urethra and proximity to the anus, which facilitate E. coli colonization from the gastrointestinal tract (Codelia-Anjum et al., 2023). Shaikh et al. reported that up to 90% of UTIs in girls are caused by E. coli. E. coli remains the dominant pathogen across all pediatric age groups, with an increasing trend in incidence as children grow older, consistent with the findings of this study.

Klebsiella pneumoniae consistently ranked as the second most common pathogen. Klebsiella pneumoniae is a Gram-negative, encapsulated, non-motile rod belonging to the Enterobacteriaceae family. Infection begins with adhesion mediated by fimbriae (mrkD) and pili that facilitate attachment to the urinary tract epithelium. Its thick polysaccharide capsule, particularly in serotypes K1 and K2, helps evade phagocytosis and enhances virulence. The bacterium also produces siderophores (entB, iucA) for iron acquisition and possesses genes such as rmpA and wabG that strengthen capsule structure. Biofilm formation on epithelial surfaces or catheters confers resistance to antibiotics and host immune responses. Many Klebsiella pneumoniae strains now produce extended-spectrum β-lactamases (ESBLs) or carbapenemases, complicating therapy and increasing the risk of recurrent infections. Upper urinary tract involvement (pyelonephritis) may occur, particularly in patients with vesicoureteral reflux or urinary tract anatomical abnormalities.

The higher distribution of Klebsiella pneumoniae in infants and children aged 12–59 months may be related to immature immunity and increased exposure to hospital environments, particularly among hospitalized children or those undergoing medical procedures. In this study, Klebsiella pneumoniae was more prevalent in males (14%) than females (7%), likely due to a combination of anatomical, physiological, and microbiological factors. A longer urethra and the presence of the prepuce in uncircumcised boys provide a niche for bacterial colonization. Additionally, urinary tract anomalies such as CAKUT, posterior urethral valves, and vesicoureteral reflux—which are more common in males—increase the risk of infection.

Pseudomonas aeruginosa (12%) and Proteus mirabilis (7%) were the next most frequently identified pathogens. Pseudomonas aeruginosa is a Gram-negative, facultative aerobic, motile bacterium capable of surviving in harsh environments and forming robust biofilms (El Husseini et al., 2024). It adheres to urinary tract epithelium via pili, flagella, and type IV adhesins, enabling colonization and ascent against urinary flow to the kidneys under predisposing conditions. Once attached, biofilm formation confers resistance to immune defenses and antibiotics; approximately 89.4% of isolates demonstrate high biofilm-forming capacity. The bacterium also produces Exotoxin A, LasA/LasB proteases, and siderophores that enhance virulence and survival in iron-poor urine (Jurado-Martín et al., 2021). This study found a higher prevalence of Pseudomonas aeruginosa in males and a predominance in the 1–5-year age group. The presence of Pseudomonas aeruginosa is often associated with nosocomial UTIs, urinary catheter use, or underlying comorbidities (Codelia-Anjum et al., 2023). Increased incidence of catheter-associated UTIs caused by Pseudomonas aeruginosa is largely attributable to its strong biofilm-forming ability on catheter surfaces, which protects it from host immunity and antimicrobial therapy, leading to persistent infection (Gmiter & Kaca, 2022). This is supported by a study from India reporting that among 62 patients with catheter-associated UTIs, 48% of male patients developed UTIs related to catheter use (Lalitha et al., 2022).

Proteus mirabilis is a Gram-negative, highly motile bacterium characterized by swarming behavior on solid surfaces (Gmiter & Kaca, 2022). It produces urease, an enzyme that hydrolyzes urea into ammonia and carbon dioxide, increasing urine pH and promoting alkaline conditions (Zhou et al., 2023). This facilitates the formation of struvite (magnesium ammonium phosphate) crystals and urinary stones, particularly in complicated UTIs. Proteus mirabilis possesses multiple virulence factors, including fimbriae/adhesins, motility, biofilm formation, hemolysins, and proteases that damage host tissues. In this study, Proteus mirabilis was more prevalent in males and most commonly observed in the 1–5-year age group. However, a study from Iraq reported a higher prevalence of Proteus mirabilis UTIs in girls (80.9%) compared with boys (19%). Most pediatric UTIs result from bacteria ascending through the urethra, and girls are generally at higher risk due to a shorter urethra and proximity to the rectum (Hassooni et al., 2025).

Gram-positive bacteria are rarely the primary causative agents of pediatric UTIs (Sultana et al., 2024). A study from Taiwan reported that Gram-positive pathogens accounted for only 4.4% of first-time pediatric UTIs, whereas Gram-negative bacteria predominated (95.6%) (Jurado-Martín et al., 2021). This observation is consistent with the present findings. In this study, Enterococcus faecalis (4%) was the most common Gram-positive pathogen causing UTIs in infants and preschool-aged children, likely related to translocation of normal gastrointestinal flora to the urinary tract (Codelia-Anjum et al., 2023).

Multiple antibiotic classes are available for the management of urinary tract infections (UTIs), administered via oral or parenteral routes. In this study, Escherichia coli isolates demonstrated varying degrees of susceptibility to parenteral agents, with the highest sensitivity observed for cefoperazone–sulbactam (60%), followed by meropenem and piperacillin–tazobactam (each 53%), gentamicin (42%), cefepime (37%), tigecycline (31%), levofloxacin (31%), and amikacin (29%). In contrast, a high rate of resistance to ampicillin was identified (65%). Regarding oral antibiotics, E. coli showed preserved susceptibility to nitrofurantoin (74%) and fosfomycin (71%), whereas sensitivity to trimethoprim–sulfamethoxazole was considerably lower (40%). These findings are consistent with the results of a study conducted by Adhima et al., which found that Escherichia coli exhibited high sensitivity to amikacin, imipenem, meropenem, piperacillin–tazobactam, tigecycline, nitrofurantoin, gentamicin, and cefoperazone–sulbactam, while showing ≥70% resistance to ampicillin, cefazolin, piperacillin, tetracycline, and trimethoprim–sulfamethoxazole.

In summary, the findings of this study indicate that pediatric UTIs exhibit variability according to age, sex, and causative bacterial species. Escherichia coli and Klebsiella pneumoniae remain the principal pathogens, with E. coli predominating in females and a more diverse bacterial spectrum—particularly Klebsiella, Proteus, and Pseudomonas—observed in males. These results underscore the importance of early detection, appropriate laboratory evaluation, and rational antibiotic selection based on local bacterial patterns to reduce UTI-related morbidity in children.

This study has several limitations. Selection bias may have occurred due to potentially influenced by prior antibiotic exposure. Variability in urine collection methods and incomplete evaluation of antibiotic resistance patterns in non–E. coli pathogens further limit interpretation. Additionally, clinical outcomes and potential confounding factors were not assessed. Despite these limitations, this study provides valuable baseline data on the clinical and bacteriological profile of pediatric UTIs in a tertiary care setting.

CONCLUSION

Urinary tract infections (UTIs) among pediatric patients at Ngoerah Hospital during the 2020–2025 period occurred most frequently in children older than 5 years. The sex distribution was relatively balanced; however, females were more frequently affected by Escherichia coli-associated UTIs. Overall, Escherichia coli (38%) and Klebsiella pneumoniae (21%) were the predominant causative organisms across all age groups, whereas other pathogens, including Pseudomonas aeruginosa, Proteus mirabilis, and Enterococcus faecalis, were identified less frequently. Fever was the most common clinical manifestation, while typical UTI symptoms, such as dysuria, were observed in only a minority of patients. These findings highlight the importance of early detection through appropriate laboratory investigations and the selection of rational antimicrobial therapy based on local bacterial patterns to reduce UTI-related morbidity in children.

Future research should focus on prospective multicenter studies to validate these findings and incorporate analyses of risk factors, clinical outcomes, and the molecular epidemiology of antimicrobial resistance to support the development of evidence-based guidelines for the management of pediatric UTIs in this setting

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