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RESEARCH ARTICLE

Prevalence, Risk Factors, and Antibiotic Susceptibility Patterns of Urinary Tract Infections in Adolescent Girls: A Cross-Sectional Study

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Abstract: ***Background***: This includes urinary tract infections (UTIs), which constitute a significant public health issue affecting adolescent girls, especially in underprivileged areas where behavioral and hygiene-related risk factors impact their health. This six-month cross-sectional study examines the prevalence of E. coli and other uropathogens among symptomatic females aged 10-19 years, as well as their associated risk factors and antibiotic susceptibility. The research was conducted at Saveetha Medical College, India. A total of 296 participants were included after excluding those who had recently taken antibiotics or lacked consent. Structured questionnaires collected data on menstrual hygiene, water intake, and perineal cleaning. A midstream urine sample was analyzed using standard microbiological methods, with antibiotic sensitivity interpreted according to CLSI 2022 guidelines. E. coli was identified as the most common pathogen, with a prevalence of 26% among those aged 14-18 years. Significant risk factors for UTI included low water intake (69.93%), poor menstrual hygiene (54.05%), and improper perineal cleaning (46.96%). Independent associations with increased risk of UTI were observed for poor hydration (adjusted OR, 2.3), menstrual hygiene (OR, 2.1), and perineal hygiene (OR, 1.9). Among the participants, 30.74% reported vaginal discharge. E. coli showed high sensitivity to Polymyxin B, Meropenem, and Tobramycin, with complete sensitivity to Piperacillin-Tazobactam and Colistin. These findings underscore the importance of hygiene education and community-based health programs in reducing risks and combating antibiotic resistance. Ongoing local surveillance is crucial for guiding the development of treatment strategies.

Keywords: Urinary tract infection in adolescents, E. coli uropathogens, behavioural risk factors, menstrual health, Antibiotic resistance patterns, perineal hygiene practices.

INTRODUCTION

Urinary tract infections (UTIs) are among the most common bacterial infections worldwide, with approximately 150 million cases occurring each year. Due to physiological and anatomical differences, UTIs are more prevalent in women [1, 2]. About 20–30% of Indian adolescent girls experience a symptomatic UTI at least once a year [3]. However, due to social stigma, limited knowledge, and inadequate healthcare services, many cases go undiagnosed or are inadequately treated [4]. Hormonal changes, the onset of menstruation, and hygiene habits formed during adolescence contribute to a greater vulnerability to developing a UTI [5].

Recent studies show that modifiable habits are now considered key factors in the development of UTIs for this age group. Poor perineal hygiene, infrequently changing sanitary items, and using cloth pads tend to increase infection risk by 2–3 times [6]. Also, inadequate hydration—generally less than 1.5 liters a day—is observed in more than 70% of adolescent girls with UTIs and hinders urinary pathogen clearance [7]. A study conducted earlier in South India has shown these behaviors significantly correlate with the prevalence and patterns of antimicrobial resistance toward Escherichia coli (E. coli) induced UTIs [8].

E. coli continues to dominate other uropathogens, accounting for 70-90 percent of both community- and hospital-acquired UTIs [9]. Its pathogenicity is enhanced by virulence mechanisms such as fimbrial adhesion, hemolysin production, and biofilm formation [10]. Particularly concerning is the rising number of multidrug-resistant (MDR) and Extended Spectrum Beta Lactamase (ESBL) producing strains, which render first-line antibiotics ineffective in areas where empirical treatment is standard and surveillance is limited [11, 12]. Reports from South India, showing a 60% MDR rate among E. coli isolates, highlight the urgent need for region-specific antimicrobial stewardship [13]. Adolescent girls are overlooked in research, leaving only an aging population studied, which is particularly worrying in low- and middle-income nations. A lack of understanding about their hygiene practices, water access, and symptom self-recognition skills hampers the development of effective preventive measures [14].

This gap was addressed through a cross-sectional study conducted over six months at Saveetha Medical College in Tamil Nadu. The research sought to assess the prevalence of E. coli and other uropathogenic microorganisms in clinically screened adolescent girls aged 10–19 years with UTI symptoms. Additionally, the

study evaluated behaviors comprising menstrual hygiene practices, fluid intake, perineal cleansing routines, patterns of antimicrobial resistance for tailored treatments, as well as specific washing routines. This investigation aims to enhance evidence-based medicine and public health strategies tailored to adolescents by highlighting local, adaptable risk factors and modifying treatment approaches based on the identified microbial profile within the region.

MATERIALS AND METHODS

This cross-sectional study aims to assess the prevalence, risk factors, and variations in antibiotic susceptibility of urinary tract infections (UTIs) in females aged 10-19 years. The study was done at Saveetha Medical College, Thandalam, from June to November of 2024. Patients of both genders were collected from the outpatient department and inpatient wards of the hospital.

Burning micturition, increased frequency of urination, and pain during urination were symptoms included for eligible participants who were within the age limit of 10-19 years. A history of obstetric or gynaecologic conditions that suggested urinary structural divergence, receiving antibiotic therapy two weeks before admission, or having a chronic illness that could impair normal urinary system functions were among the exclusion criteria. When the participant or guardian consented, participation was conducted using a consecutive sampling method.

The other main outcomes include collecting urine samples and analyzing them for E. coli and other bacterial pathogens, along with secondary outcomes such as examining patterns of antibiotic susceptibility and poor menstrual hygiene. These are linked to infrequent vigorous perineal washing combined with low liquid intake, which are identified as contributing risk factors. Behavioral measures, along with socio-economic status, served as confounding variables, and stratifying them under primary exposures allowed age and prior UTI history to be considered determinants.
Academic and clinical insights, hygiene-related metrics, and demographic details were collected through interviews and structured questionnaires during clinical visits.

We obtained midstream urine samples in sterile containers and worked on them within the hour. The identification of the microbe was performed using standard culture techniques with MacConkey agar plates. Antibiotic susceptibility testing was performed according to the 2022 CLSI guidelines [15, 16] using the disc diffusion method.
Sample size was estimated based on an anticipated prevalence of 26%, a 5% margin of error, and a 95% confidence interval. A 10% cushion for dropouts raised the final sample size estimate to 326 participants [17,18]. Descriptive statistics captured demographics, symptoms, and laboratory results. Logistic regression was used to evaluate the associations between hygiene covariates and the occurrence of UTIs, while controlling for confounders [19, 20]. Comparisons were made across classes for antibiotic resistance.

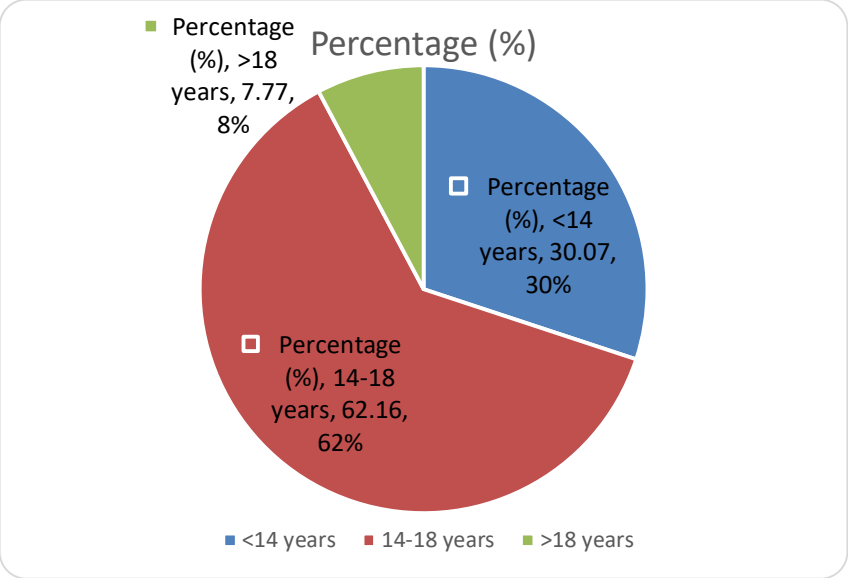
RESULTS AND OBSERVATIONS:

A total of 326 adolescent girls, aged 10 to 19 years, were approached to participate in the study. Of those, 296 met the eligibility criteria and were included. Thirty participants were excluded because they had used antibiotics before (n = 18) or had incomplete consent forms (n = 12). All 296 participants completed the study, and their data were analysed. The age distribution revealed that 30.07% of participants were under 14 years (n=89), 62.16% were aged 14–18 years (n=184), and 7.77% were above 18 years (n=23), with a mean age of 15.4 years (SD ± 2.1) (Table 1) (Figure 1).

Table 1: Age Group Distribution of Participants

Age Group	Number (n)	Percentage (%)
<14 years	89	30.07
14-18 years	184	62.16
>18 years	23	7.77

Figure 1: Age Group Distribution (%) of Participants

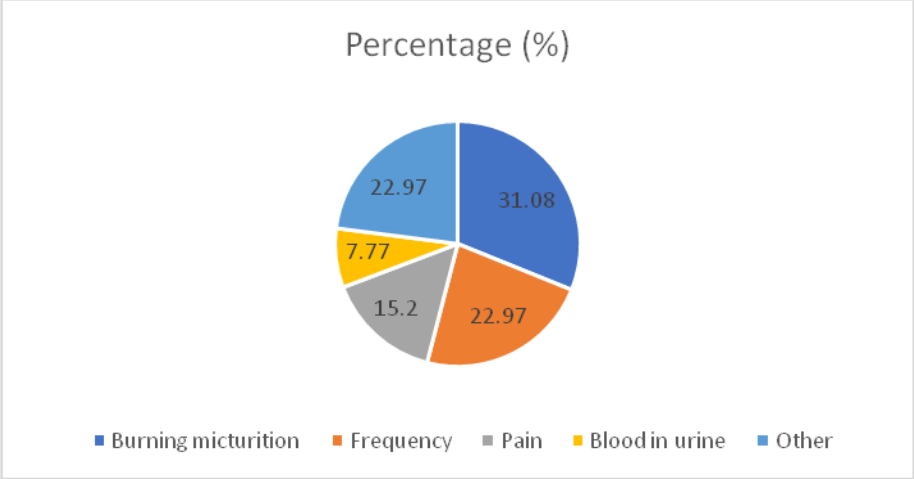


Burning micturition (31.08%, n=92), increased frequency (22.97%, n=68), pain during urination (15.20, n=45), and blood in urine (7.77%, n=23) were the most frequently reported symptoms, with 22.97% (n=68) reporting other symptoms (Table 2) (Figure 2).

Table 2: Distribution of Symptoms among Adolescent Girls with UTIs

Symptoms	Number (n)	Percentage (%)
Burning micturition	92	31.08
Frequency	68	22.97
Pain	45	15.2
Blood in urine	23	7.77
Other	68	22.97

Figure 2: **Percentage of Reported Symptoms in Adolescent Girls with UTIs**

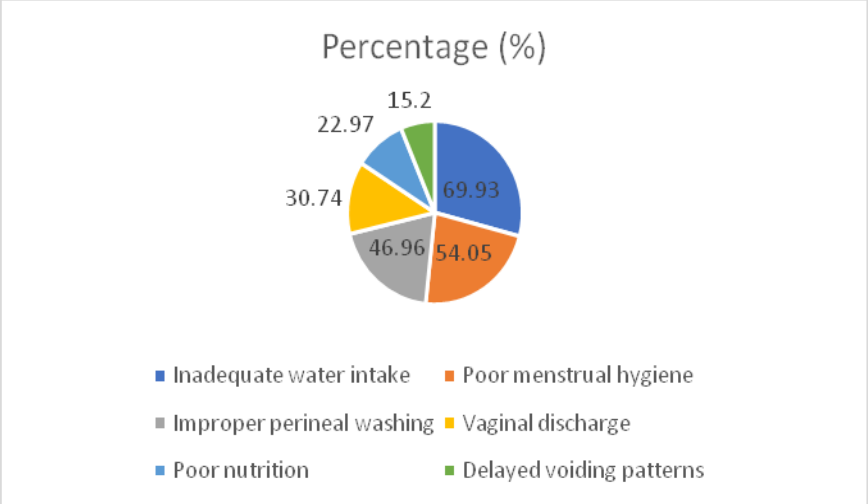


According to the risk factor assessment, 46.10% (n = 139) improperly washed their perineal area, 53.80% (n = 160) reported poor menstrual hygiene, and 69.20% (n = 207) drank less than four glasses of water per day. Vaginal discharge (30.70%, n = 91), inadequate nutrition (23.00%, n = 68), and a delayed voiding pattern (15.30%, n = 45) were additional contributing factors (Table 3) (Figure 3).

Table 3: Frequency and Percentage of Risk Factors Contributing to UTIs in Adolescent Girls

Risk Factors	Number (n)	Percentage (%)
Inadequate water intake	207	69.93
Poor menstrual hygiene	160	54.05
Improper perineal washing	139	46.96
Vaginal discharge	91	30.74
Poor nutrition	68	22.97
Delayed voiding patterns	45	15.2

Figure 3: Percentage Distribution of Risk Factors Associated with UTIs Among Adolescent Girls

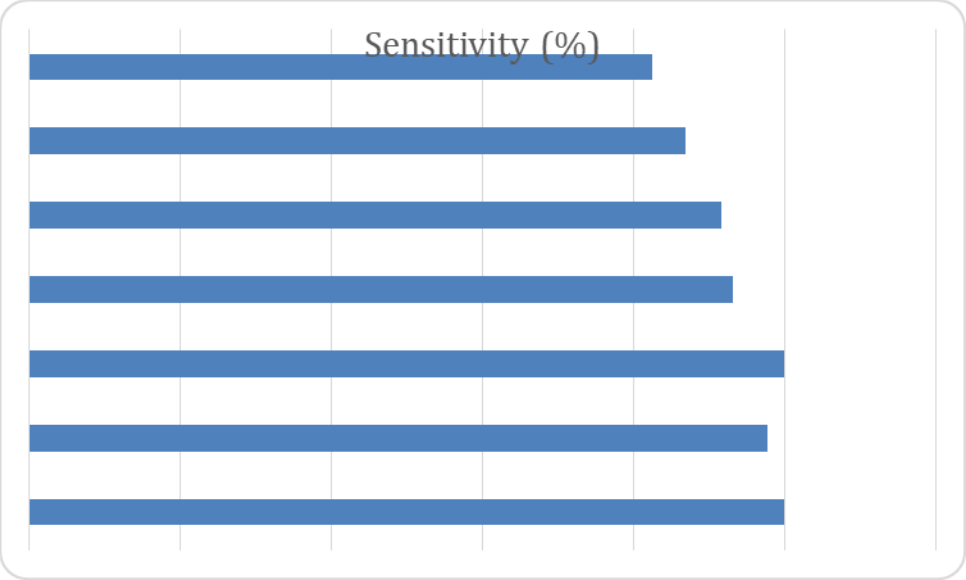


Escherichia coli was identified as the causative pathogen in 26% (n=77) of the 296 participants, while other bacterial isolates accounted for 74% (n=219). The antibiotic sensitivity profile of *E. coli* showed the highest sensitivity to Piperacillin-Tazobactam (100%), Colistin (100%), and Polymyxin B (97.8%), followed by Meropenem (93.1%), Tobramycin (91.6%), Imipenem (86.9%), and Tigecycline (82.5%) (Table 4) (Figure4).

Table 4: Antibiotic Sensitivity Patterns of Escherichia coli Isolates from UTI Cases

Antibiotic	Sensitivity (%)
Piperacillin-Tazobactam	100
Polymyxin-B	97.8
Colistin	100
Meropenem	93.1
Tobramycin	91.6
Tigecycline	86.9
Imipenem	82.5

Figure 4: Percentage Sensitivity of Escherichia coli to Various Antibiotics



Logistic regression analysis revealed significant associations between UTIs and poor menstrual hygiene (OR 2.1, 95% CI: 1.5, 2.8), improper perineal washing (OR 1.9, 95% CI: 1.4, 2.5), and insufficient water intake (OR 2.5, 95% CI: 1.8, 3.4). The most significant predictor of UTIs was inadequate water intake, after adjusting for socioeconomic status and age (adjusted OR 2.3, 95% CI: 1.6, 3.2). Participants aged 14 to 18 had the highest rate of UTIs caused by Escherichia coli (62.16%), based on subgroup analysis. Sensitivity analyses confirmed the robustness of these findings by excluding cases with incomplete symptom data.

According to the risk factor assessment, 46.10% (n = 139) improperly washed their perineal area, 53.80% (n = 160) reported poor menstrual hygiene, and 69.20% (n = 207) drank less than four glasses of water per day. Vaginal discharge (30.70%, n = 91), inadequate nutrition (23.00%, n = 68), and a delayed voiding pattern (15.30%, n = 45) were additional contributing factors (Table 3) (Figure 3).

These findings highlight the importance of modifiable risk factors in the development of UTIs in teenage girls, including proper hydration, menstrual hygiene, and perineal washing habits. They stress the need for targeted interventions to address these factors and reduce the impact of UTIs in this vulnerable group.

DISCUSSION

This study aims to determine the prevalence of urinary tract infections (UTIs) among adolescent girls, their associated risk factors, and related antimicrobial susceptibility patterns in a tertiary care facility. Findings support the central hypothesis that Escherichia coli remains one of the most common uropathogens, accounting for 26% of UTI cases. This aligns with the literature, which describes E. coli as the cause in 70-90% of uncomplicated UTIs worldwide [9].

Based on the participants' age distribution, 62.16% of them were between 14 and 18 years old, suggesting that this developmental stage is particularly vulnerable to these infections. Contributing factors may include hormonal changes, increased menstrual activity, and the development of personal care and hygiene habits during this stage [5]. This subgroup showed the highest rates of infections related to E. coli. This indicates the need for targeted prevention and education programs for these age groups.

The predominant symptom reported was burning micturition (31.08%), followed by increased frequency (22.97%), and dysuria (15.2%). These results align with documented signs and symptoms associated with UTIs across different age groups [1, 2]. Notably, non-specific "other" symptoms were reported by 22.97%, which reinforces the deception label symptomatology that adolescents might otherwise associate with it, emphasizing the need for broad clinical reasoning [3].

Risk factor analysis revealed that low water intake (less than 4 glasses a day) was the most common contributor at 69.93%. This was followed by poor menstrual hygiene at 54.05% and improper perineal washing at 46.96%. These factors were strongly associated with the occurrence of UTIs. Specifically, low water intake

demonstrated the strongest independent link, with an adjusted odds ratio of 2.3 and a 95% confidence interval of 1.6 to 3.2. This supports previous findings that low fluid intake reduces urinary output, which promotes bacterial growth and spread. Menstrual hygiene practices pose risks due to infrequent changing of unclean pads and the use of dirty pads, which can lead to UTIs and other reproductive tract infections [4, 8]. The odds ratio we calculated supports previous research (OR 2.1, 95% CI: 1.5–2.8). Incorrect perineal washing, such as washing from back to front, increases the risk of introducing intestinal germs to the urinary system, as shown by other epidemiological studies [9].

A key finding in this study is the high co-occurrence of vaginal discharge (30.74%) with UTIs. This suggests a possible overlap between urinary and reproductive tract infections in adolescent girls. It calls for more microbiological research into the pathogens that occur together and the role of imbalances in vaginal bacteria in UTI risk. From a microbial perspective, the antibiotic sensitivity profile of E. coli isolates showed complete sensitivity to piperacillin-tazobactam and colistin. High sensitivity was also found for polymyxin B (97.8%), meropenem (93.1%), and tobramycin (91.6%). This aligns with other studies on drug-resistant UTIs. However, the likely high resistance seen with first-line agents like ampicillin or trimethoprim-sulfamethoxazole, although not reported here, suggests possible misuse or overuse of these antibiotics in community settings. Another important observation is the relatively high effectiveness of tigecycline (86.9%) and imipenem (82.5%), which have previously demonstrated varied success against multidrug-resistant UTI pathogens. This pattern may reflect local susceptibility trends and highlights the need for regular updates on antibiotic sensitivity to inform treatment decisions. Sensitivity analyses that excluded participants with incomplete symptom data further reinforced the strength of these associations, thereby reducing the likelihood of misclassification bias. Subgroup analysis further identified high-risk profiles, especially among mid-adolescent girls. This provides valuable information for targeted health education programs in schools and community clinics. Overall, these findings emphasize the role of modifiable behavior and hygiene factors in the development of UTIs. Identifying inadequate hydration as the strongest and most consistent predictor of UTI risk is a crucial public health insight, especially in areas where access to water and awareness of its importance might be limited.

CONCLUSION

The study shows that the most predominant uropathogenic bacteria affecting teenage girls with UTIs are Escherichia coli. It also highlights the significant relationship between infection risk and modifiable behaviours, particularly poor menstrual hygiene, low water intake, and insufficient perineal washing. E. coli reported susceptibility to strong antibiotics like Piperacillin-Tazobactam and Polymyxin B offers hope for treating some resistant infections. The notable susceptibility of E. coli to broad-spectrum antibiotics such as Piperacillin-Tazobactam and Polymyxin B provides promising options in the fight against resistance. Important insights, such as the role of hydration status and vaginal discharge in relation to UTIs, warrant further exploration into other preventive strategies. Improvements in this area will come through education about proper fluid intake combined with good menstrual hygiene practices aimed at enhancing perineal washing among young school-aged girls. There is an urgent need for local surveillance on antimicrobial resistance to develop appropriate treatment guidelines and prevent the spread of resistant infections.

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Conflict of Interests

The authors declare there is no conflict of interest for thi

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