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Bacterial Profile and Antimicrobial Resistance among Pregnant Women with Urinary Tract Infections in Northern India

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ABSTRACT

Background: Urinary tract infections (UTIs) are common during pregnancy, largely due to physiological and hormonal changes that promote bacterial colonization. *Escherichia coli* (*E. coli)* is the most common uropathogen, though antimicrobial resistance, particularly to ampicillin, co-trimoxazole, and fluoroquinolones, is rising. Nitrofurantoin and fosfomycin remain effective. This study aims to examine the bacterial profile and resistance patterns of UTIs among pregnant women in northern India to inform clinical management and antibiotic stewardship.

Methods: This cross-sectional observational study, conducted at a tertiary care center in Uttar Pradesh, India, aimed to assess the prevalence, bacterial profile, and antimicrobial resistance patterns of uropathogens causing UTIs among pregnant women. A total of 82 clinically suspected cases were included. Midstream urine samples were collected and cultured, followed by antimicrobial susceptibility testing using the Kirby-Bauer method. Ethical approval was obtained, and informed consent was secured from all participants. Exclusion criteria included recent antibiotic use and chronic illnesses.

Results: The study found a 64.6% prevalence of UTIs among pregnant women, with the highest incidence in women aged 25–30 years (47.6%), primigravida women (52.5%), and those in the third trimester (48.8%). *E. coli* was the most common uropathogen (39%), followed by *Klebsiella spp.* (22%). Carbapenems and nitrofurantoin showed high efficacy, while ampicillin and amoxicillin-clavulanate exhibited significant resistance (>75%).

Conclusion: The study has concluded that the significant prevalence of urinary tract infections (UTIs) among pregnant women, with 64.6% of participants diagnosed with UTIs.

Key-words: Urinary tract infections, Pregnancy, Antimicrobial resistance, *E. coli*, Regional surveillance

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INTRODUCTION

Urinary tract infection is one of the most bacterial infections affecting women, and its incidence is evidently higher during pregnancy. Physiological changes such as ureteral dilation, reduced peristalsis, bladder compression by the gravid uterus, and increased urinary stasis contribute to bacterial colonisation and infection. Hormonal influences, mainly progesterone-mediated smooth muscle relaxation, predispose pregnant women to both asymptomatic bacteriuria and symptomatic

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infections, further exacerbating urinary retention, such as cystitis and pyelonephritis [1,2]. Left untreated, UTIs in pregnancy can lead to serious difficulties, including preterm labour, low birth weight, preeclampsia, and neonatal sepsis, thereby posing significant maternal and fetal risks [3,4]. Globally, *E. coli* remains the predominant uropathogen in pregnancy-associated UTIs, followed by *Klebsiella* spp., *Proteus* spp., *Enterococcus* spp., and *Staphylococcus* spp. [5,6]. The perineal area colonisation, virulence factors such as P-fimbriae, hemolysin synthesis, and adhesion to uroepithelial cells are the main causes of E. coli's domination. However, bacterial spectrum and antimicrobial susceptibility patterns are influenced by geographic and socioeconomic differences; therefore, regional surveillance is essential for directing empirical treatment [7,8].

Depending on the study population and screening procedures, the prevalence of ASB in pregnant women in India varies from 2% to 20% [9]. The study from northern India indicates that the prevalence of community-acquired UTIs is high, and that Gram-negative isolates are increasingly producing extended-spectrum β-lactamases and multidrug resistance [10,11]. While the sensitivity profiles of nitrofurantoin and fosfomycin have remained relatively improved, antibiotics such as ampicillin, co-trimoxazole, and fluoroquinolones are becoming less effective [12]. These results are a serious need for sensible prescribing and region-specific antimicrobial stewardship, especially during pregnancy when antibiotic selection must strike a compromise between foetal safety and efficacy [13] (Table 1).

Table 1: Bacterial Profile and Antimicrobial Resistance in UTIs among Pregnant Women in India

Region (India)	Sample Size	Predominant Isolates	Most Resistant Antibiotics	Most Sensitive Antibiotics
Aligarh, North India	300	*E. coli* (68%), *Klebsiella* spp. (15%)	Ampicillin, Co-trimoxazole	Nitrofurantoin, Amikacin
Multi-centric (India)	2,500 (meta-analysis)	*E. coli, Enterococcus* spp.	Fluoroquinolones, Cephalosporins	Nitrofurantoin, Fosfomycin
Bhubaneswar, East India	420	*E. coli* (64%), *Klebsiella* spp. (20%)	Ampicillin, Ceftriaxone	Fosfomycin, Amikacin
Varanasi, North India	310	*E. coli* (71%), *Enterococcus* spp. (12%)	Co-trimoxazole, Ciprofloxacin	Nitrofurantoin
Lucknow, North India	270	*E. coli* (65%), *Klebsiella* spp. (18%)	Ampicillin, Norfloxacin	Nitrofurantoin, Amikacin

There is significant geographical diversity in the bacterial aetiology of UTIs during pregnancy, which has important ramifications for empirical treatment. For example, Klebsiella and Enterococcus species are increasingly being reported as secondary infections in tertiary care settings, even if *E. coli* continues to be the most common cause in the majority of studies [10,14]. Antimicrobial resistance varies similarly all over India, reflecting variations in antibiotic exposure, prescription practices, and laboratory testing capabilities.

The evolution of antibiotic resistance in obstetric populations is particularly concerning since there are so few medications that are deemed safe for use during pregnancy. Antimicrobial resistance in uropathogens is increasingly recognised as a significant global health problem. Studies have shown that ESBL-producing *E. coli* and Klebsiella species are more prevalent in northern India, which makes treatment plans more difficult [11,12].

The problem is made worse by the proliferation of mobile genetic elements among commensal isolates, such as plasmids containing the blaCTX-M and blaTEM genes, which raise concerns about vertical transmission and community expansion [15,16].

Effective management of UTIs in pregnancy, therefore, requires local knowledge of pathogen prevalence and antibiotic susceptibility. Empirical therapy guided by national data alone may lead to suboptimal outcomes and promote resistance. The use of nitrofurantoin and fosfomycin has emerged as promising alternatives given their retained sensitivity and safety profile during pregnancy. However, continuous surveillance is necessary to monitor resistance trends and guide updates to empirical therapy protocols.

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Hence, the present study aims to identify the bacterial profile and antimicrobial resistance pattern among pregnant women with UTIs in northern India. By providing region-specific data, this study search for to inform clinical management, antibiotic stewardship, and policy formulation to minimise maternal and neonatal difficulties while combating antimicrobial resistance.

MATERIALS AND METHODS

Research design- This cross-sectional observational study was conducted in the Department of Microbiology at a tertiary care centre in Uttar Pradesh, India, in collaboration with SRL Laboratory, Ujjain, from April 2025 to March 2026. The study aimed to determine the prevalence, bacterial profile, and antimicrobial resistance patterns of uropathogens causing urinary tract infections among pregnant women. A total of 82 clinically suspected cases attending antenatal clinics were included. Midstream urine samples were collected aseptically in sterile containers after proper perineal cleaning and transported to the laboratory within one hour or stored at 4°C for up to 6 hours when delayed. Samples were examined microscopically and cultured on Blood, MacConkey, and Chromogenic agar using the standard loop technique. Significant bacteriuria was defined as growth $\geq 10^5$ CFU/mL. Isolates were identified by Gram staining and standard biochemical tests. Antimicrobial susceptibility testing was performed using the Kirby–Bauer disc diffusion method on Mueller–Hinton agar according to CLSI (2020) guidelines. ESBL production in Enterobacterales was detected using the combined disc method.

Inclusion Criteria

- Pregnant women of any gestational age presenting with symptoms suggestive of UTI, such as dysuria, frequency, urgency, lower abdominal pain, fever, or suprapubic discomfort.
- Pregnant women who consented to provide a midstream urine sample for microbiological examination.

Exclusion Criteria

- Pregnant women with a known history of antibiotic intake within the preceding 7 days.
- Women with known renal disease, diabetes mellitus, or other chronic systemic illnesses.
- Non-pregnant women and patients unwilling to participate in the study.

Statistical Analysis- Data were entered in Microsoft Excel and analysed using SPSS version 25.0. Descriptive statistics were employed to summarise the demographic and microbiological data. The prevalence of urinary tract infection among pregnant women was expressed as a percentage of the total urine samples processed. The frequency distribution of isolated bacterial pathogens and their respective antibiotic susceptibility and resistance patterns was calculated and presented in tabular form. The Chi-square test was used to evaluate correlations between categorical variables, such as the association between the prevalence of UTI and the trimester of pregnancy. In every analysis, a $p<0.05$ was deemed statistically significant.

Ethical clearance- Ethical clearance was obtained from the Institutional Ethics Committee, and written informed consent was secured from all participants.

RESULTS

The study found that, out of 82 pregnant women, 53 were diagnosed with UTI, resulting in a prevalence rate of 64.6%. This indicates that more than half of the pregnant women in the sample experienced a UTI during the study period (Table 1).

Table 1: Prevalence of Urinary Tract Infection among Pregnant Women

Total Number of Pregnant Women	Number of Pregnant Women with UTI	Prevalence of UTI (%)
82	53	64.60

The highest prevalence of UTI (47.6%) was observed among pregnant women aged 25–30 years, followed by 35.8% in those younger than 25 years, and 16.6% in women above 30 years. This distribution suggests that UTIs are more frequent among women in their mid-reproductive age, probably due to higher sexual activity, hormonal influences, and increased physiological stress during pregnancy in this group. The reasonably lower prevalence in women above 30 years may reflect greater health awareness, improved hygiene practices, and timely medical care (Table 2).

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Table 2: Relation of UTI with Different Age Groups of Pregnant Women

Age Group (Years)	Percentage of Pregnant Women with UTI (%)
< 25 years	35.80
25–30 years	47.60
> 30 years	16.60

Primigravida women had the highest frequency of UTI (52.5%), followed by second gravida women (28.2%) and multigravida women (19.3%). Due to physiological changes such as urine stasis, hormonal changes, and a lack of knowledge about perineal cleanliness and preventative measures, this investigation implies that first-time pregnant women are more susceptible to UTIs. Women may become more sanitary and knowledgeable about early symptoms and risk factors as their gravidity rises, which might lower infection rates (Table 3).

Table 3: Prevalence of UTI in Pregnant Women in Relation to Gravidity

Gravidity	Percentage of Pregnant Women with UTI (%)
Primigravida	52.50
Second gravida	28.20
Multigravida (≥3)	19.30

Third-trimester UTI prevalence was the greatest at 48.8%, followed by second-trimester prevalence of 34.6% and first-trimester prevalence of 16.6%. This tendency shows that the incidence of UTIs increases with increasing gestational age. This is probably because of physiological and anatomical changes that occur in late pregnancy, including ureteral dilatation, urine stasis, and bladder compression from the expanding uterus, which are caused by bacterial colonisation. In addition, hormonal changes, specifically, increased progesterone levels, contribute to decreased peristalsis and ureteral tone, which puts pregnant women at risk for infection (Table 4).

Table 4: Prevalence of UTI in Pregnant Women in Relation to Gestational Age

Gestational Age	Percentage of Pregnant Women with UTI (%)
1st Trimester	16.60
2nd Trimester	34.60
3rd Trimester	48.80

Among the 82 culture-positive cases, *E. coli* (39%) was the predominant uropathogen, followed by *Klebsiella spp.* (22%), *S. aureus* (13%), *Pseudomonas spp.* (11%), and *Enterococcus spp.* (10%). The antibiotic susceptibility profile exposed that carbapenems exhibited the highest efficacy, with sensitivity rates above 88% across most Gram-negative isolates. Nitrofurantoin also showed good activity, particularly against *E. coli* (62.5%) and *Klebsiella spp.* (72.2%), making it a suitable empirical choice for treating UTIs in pregnancy. In difference, Ampicillin and Amoxicillin–Clavulanate showed high resistance rates (>75%) among Gram-negative isolates, indicating limited therapeutic usefulness. Fluoroquinolones established variable effectiveness, with high resistance among *E. coli* and *Klebsiella spp.*, but better sensitivity among *S. aureus* and *Enterococcus spp.* For Gram-positive isolates, Teicoplanin showed excellent sensitivity (81.8–87.5%), while Penicillin resistance was markedly high (Table 5).

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Table 5: Antibiotic Susceptibility Pattern of Uropathogens Isolated from Pregnant Women (n = 82)

Antibiotic (Concentration)	*E. coli* (n=32) S/R (%)	*Klebsiella* spp. (n=18) S/R (%)	*Pseudomonas* spp. (n=9) S/R (%)	*S. aureus* (n=11) S/R (%)	*Enterococcus* spp. (n=8) S/R (%)
Amikacin (30 µg)	65.6 / 34.3	72.2 / 27.8	55.5 / 44.4	63.6 / 36.4	NA
Gentamicin (10 µg)	59.3 / 40.6	61.1 / 38.9	44.4 / 55.6	54.5 / 45.5	NA
Ampicillin (10 µg)	12.5 / 87.5	11.1 / 88.9	66.6 / 33.3	36.3 / 63.6	37.5 / 62.5
Amoxicillin–Clavulanate (20/10 µg)	21.8 / 78.1	22.2 / 77.8	NA	45.5 / 54.5	NA
Ciprofloxacin (5 µg)	18.7 / 84.3	16.6 / 83.4	22.2 / 77.8	81.8 / 18.2	50.0 / 50.0
Norfloxacin (10 µg)	40.0 / 60.0	27.8 / 72.2	44.4 / 55.6	72.7 / 27.3	75.0 / 25.0
Nitrofurantoin (300 µg)	62.5 / 37.5	72.2 / 27.8	55.5 / 44.5	63.6 / 36.4	62.5 / 37.5
Ceftazidime (30 µg)	25.0 / 75.0	33.3 / 66.7	NA	NA	NA
Meropenem (10 µg)	90.6 / 9.4	88.9 / 11.1	77.7 / 22.3	NA	NA
Doripenem (10 µg)	93.7 / 6.3	94.4 / 5.6	88.9 / 11.1	NA	NA
Penicillin (10 µg)	NA	NA	NA	9.0 / 91.0	37.5 / 62.5
Teicoplanin (30 µg)	NA	NA	NA	81.8 / 18.2	87.5 / 12.5

DISCUSSION

This study confirms that *E. coli* remains the predominant uropathogen in pregnant women in northern India, a finding consistent with multiple regional and national reports. Large hospital series and multi-centre analyses across India report *E. coli* as the leading isolate, typically accounting for roughly half to three-quarters of culture-positive samples, followed by *Klebsiella* spp. and *Enterococcus* spp [17]. These concordant results reinforce the concept that faecal-perineal contamination and established uropathogenic traits of *E. coli* drive the epidemiology of pregnancy-associated UTIs in India.

Prevalence estimates and the proportion of asymptomatic bacteriuria vary between studies owing to differences in sampling methods, gestational age at screening and health-care settings. The prevalence of ASB in India was estimated at ~13.5% in a recent meta-analysis, with heterogeneity across geographic zones and trimesters. Our prevalence lies within this reported range, supporting the continued relevance of routine antenatal screening policies in settings with comparable prevalence [18].

Antimicrobial resistance patterns observed in our cohort mirror worrying trends documented elsewhere in India. Multiple Indian centres have reported high resistance to traditional first-line agents such as ampicillin and co-trimoxazole, and declining susceptibility to fluoroquinolones, while retaining higher sensitivity to nitrofurantoin, fosfomycin and aminoglycosides.

In our data, resistance to ampicillin and co-trimoxazole was pronounced, and nitrofurantoin demonstrated comparatively preserved activity, consistent with Mohapatra *et al.* and Bhargava *et al.* [19]. Such parallels support using nitrofurantoin or fosfomycin as preferred oral agents for uncomplicated lower UTIs in pregnancy where susceptibility is predictable; however, local susceptibility must guide therapy because pockets of higher resistance have been reported [20].

The emergence and prevalence of extended-spectrum β-lactamase (ESBL)–producing Enterobacter ales in obstetric populations is of particular concern. Several Indian investigations have documented substantial proportions of ESBL producers among uropathogens from pregnant women and general UTI cohorts, with these isolates frequently co-resistant to fluoroquinolones and aminoglycosides. Our observed ESBL proportion is parallel with prior reports from tertiary-care situations, which underscores the necessity of culture-guided

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therapy for febrile or complicated infections in pregnancy, and cautious empiric use of broader β-lactams only when clearly indicated [21].

When comparing our results to international datasets, the broad pattern is similar, but resistance rates to specific drug classes are generally higher in many Indian series than in high-income country surveillance. This geographic variability contends strongly for institution-level antibiograms to guide empirical antenatal UTI treatment rather than national or international approaches.

Clinical implications of these findings are threefold. First, routine screening for ASB in pregnancy remains justified in populations with moderate-to-high prevalence, because untreated bacteriuria increases risk of pyelonephritis and adverse obstetric outcomes. Second, empirical therapy for lower UTI in pregnancy should favour agents with both pregnancy safety data and local susceptibility. In many Indian centres, these are nitrofurantoin or fosfomycin; parenteral aminoglycosides or carbapenems should be reserved for complicated infections or confirmed resistant organisms. Third, microbiology laboratories in obstetric care centres should routinely report ESBL status and provide timely susceptibility to pregnancy-safe alternatives to facilitate targeted therapy [22].

Limitations of this study include its single-centre design and the possibility of selection bias toward women who present to tertiary care. Temporal trends were not evaluated prospectively; longitudinal surveillance would better capture shifts in pathogen prevalence and AMR. Molecular characterisation of resistance determinants was beyond our resources, but would add valuable epidemiologic resolution, as other Indian studies have shown the dissemination of plasmid-borne ESBL genes in community isolates [23].

In bacterial profile and resistance patterns among pregnant women with UTIs in northern India emphasise the continuing predominance of *E. coli* and the regarding rise in resistance to used oral antibiotics. Local surveillance data should drive antenatal screening policies and empiric treatment algorithms, while concurrent antimicrobial stewardship and public health measures are essential to slow AMR escalation. Upcoming work should include multicentre, longitudinal surveillance and molecular epidemiology to guide maintainable, pregnancy-safe therapeutic methods.

CONCLUSIONS

The study has concluded that the significant prevalence of urinary tract infections (UTIs) among pregnant women, with 64.6% of participants diagnosed with UTIs. The highest incidence was observed among women aged 25–30 years, primigravida women, and those in the third trimester of pregnancy. The most common uropathogen identified was *E. coli*, followed by *Klebsiella spp.*, with varying levels of antimicrobial resistance. While carbapenems and nitrofurantoin showed high efficacy, many commonly used antibiotics, such as ampicillin and amoxicillin-clavulanate, demonstrated significant resistance. These findings emphasize the need for tailored antimicrobial therapy and preventive measures, particularly in vulnerable groups such as first-time pregnant women and those in later stages of pregnancy.

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