Original Article

Prevalence, Determinants, and Antibiotic Resistance Patterns of Urinary Tract Infections in Antenatal Women in an Urban Resettlement Colony and Slum in Delhi, India: A Cross-sectional Study

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Abstract

Background: Urinary tract infection (UTI) is the most common bacterial infection occurring in pregnant women with untreated, recurrent, and inadequately treated bacteriuria accentuating the risk of multiple adverse fetal and maternal health outcomes. The study objective was to determine the proportion of UTIs and their predictors along with antibiotic resistance patterns of causative organisms in pregnant women. **Materials and Methods:** This cross-sectional study was conducted among 348 pregnant women in an urban resettlement and slum colony. Urine samples were examined through semi-quantitative culture on plated Mac Conkey and blood agar. Antibiotic susceptibility testing was done on Muller Hinton agar using the modified Stokes' disc diffusion method. **Results:** At least one symptom related to UTI was reported by 35.7% (95% CI: 30.7-41.1) of the participants. The proportion of pregnant women detected having UTI on urine culture was 7.4% (n = 24, 95% CI: 5.1-10.8) with 13 (54.2%) asymptomatic and 11 (45.8%) symptomatic cases. Overcrowding was a significant predictor of UTI. The most common organisms detected were *Escherichia coli* (n = 12), *Klebsiella pneumoniae* (n = 7), *Staphylococcus aureus* (n = 3), and *Acinetobacter* species (n = 2). **Conclusions:** The use of individual toilets and active screening for UTI through culture and sensitivity testing in pregnant women should be promoted in low-resource settings irrespective of symptoms. The initiation of presumptive antibiotic therapy for UTI cases in pregnant women should be restricted to painful micturition due to high false positivity of other symptoms with Nitrofurantoin being a likely preferred drug for empirical administration due to its low resistance pattern among isolated organisms.

Keywords: Antibiotic resistance, antimicrobial susceptibility, pregnant women, urinary tract infections

Introduction

Urinary tract infection (UTI) is the infection of one or more parts of the urinary system by bacteria after overcoming the natural defence mechanisms of the urinary tract.[1,2] UTI occur more commonly in women due to short urethra and proximity to the anus and vagina resulting in urethral colonization of gastro-intestinal and perineal flora.[3] UTI is the most common bacterial infection occurring in pregnant women due to higher susceptibility from morphological and physiological changes, especially dilatation of ureters, increased alkalization of urine, and reduced personal hygiene.[4,5]

Most pregnant women with UTI have a benign course, although untreated, recurrent, and inadequately treated bacteriuria can increase the risk of multiple adverse fetal and maternal health outcomes, even when the infection is asymptomatic.[6] Previous evidence suggests that 20-30% of asymptomatic bacteriuria cases in pregnancy if left untreated can complicate into acute pyelonephritis leading to renal failure, maternal sepsis, and adult respiratory distress syndrome.[7,8] The global prevalence

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of asymptomatic bacteriuria in pregnancy is estimated to be around 2-15%.[9] The prevalence of UTI (both symptomatic and asymptomatic bacteriuria) in pregnancy in India ranges from 3% to 24%, which is comparatively higher than in the developed world.[10]

The culture of the midstream urine sample is the gold standard screening test for UTI in pregnancy, but due to its high cost, it is not done routinely in most of the lower-middle-income countries (LMICs) including India.[11] Lack of facilities for regular screening for UTI in pregnancy in primary care facilities may contribute to the delay in diagnosis, drug resistance, and increased risk of complications with associated high economic costs.[6,12] Timely screening and treatment of bacteriuria in pregnancy is expected to reduce the incidence of prematurity and low birth weight by 20-55% and reduce neonatal mortality due to preterm birth by 5-14%.[13]

UTI is also the most common cause for the prescription of outpatient antibiotics amongst pregnant women and inappropriate prescription is likely to contribute to growing antimicrobial resistance (AMR) as microorganisms develop the ability to resist antimicrobial effects.[14] It is estimated that by 2050, 10 million people will be dying every year due to AMR and economic costs are estimated at $100 trillion.[15] Drivers of AMR in developing countries include increased antibiotic demand from irrational and presumptive prescribing practices, high lab turnabout time, and costs.[16,17] India was the topmost consumer of antibiotics overall with 13 billion SU (standard units) in 2010 with evidence of a high burden of resistant gram-negative and gram-positive bacteria.[18]

Prescribing antibiotics to women during pregnancy can be associated with teratogenic risks as most antimicrobials belong to the B, C, and D categories of the US Food and Drug Administration (FDA) classification system for drugs in pregnancy.[19] Increased volume of distribution and resulting altered pharmacokinetics of the drugs make it further difficult to predict the correct dose of antibiotics in pregnant women.[20] Furthermore, pregnant women reporting symptoms of UTI are frequently prescribed empirical treatment before the assessment of culture and antibiotic sensitivity to prevent disease progression and associated complications.[10] Therefore, a comprehensive knowledge of the causative bacterial species and their antibiotic susceptibility patterns in resource-limited settings is needed to ensure appropriate antibiotic treatment and stewardship practices.

There is a paucity of evidence regarding the true burden of bacteriuria in pregnancy in India as most of the existing studies were conducted in tertiary care settings while the lack of laboratory confirmation will also miss out on asymptomatic bacteriuria.[10] Women living in urban slums and resettlement colonies frequently experience adverse hygiene and sanitation challenges which can increase their susceptibility to UTI. Furthermore, increased utilization of antibiotics secondary to self-medication or inappropriate prescription in these communities may worsen the problem of antibiotic resistance. Consequently, understanding the risk factors associated with UTI during pregnancy among women reporting to primary care settings in low-resource settings can be useful in designing appropriate public health interventions for prevention and early diagnosis of this condition.

We, therefore, conducted this study with the objective of determining the proportion of UTIs among pregnant women reporting to an urban primary care setting and assessing the sociodemographic and behavioral risk factors. Furthermore, we ascertained the antibiotic resistance patterns of the causative organisms of UTI in them.

Methods

This study was a facility-based cross-sectional observational conducted in an urban primary healthcare (UHC) facility in the northeast district of Delhi catering to an estimated 29,000 low-income urban resettlement and slum-dwelling population. The study was conducted from September 2020 to August 2021. All pregnant women attending the antenatal clinic of the UHC irrespective of gestational age and presence or absence of symptoms of UTI were included in the study, while seriously ill pregnant women, with previously diagnosed cases of chronic kidney disease. Two women who had taken antibiotics in the previous 7 days were excluded.

The primary outcome was the proportion of pregnant women suffering from UTI and the secondary outcome was the AMR pattern of the causative organisms of UTI. The sample size was estimated at 95% confidence levels, 20% relative precision, expecting the prevalence of UTI in pregnant women as 24% from a previous study conducted in Northern India, and considering 10% non-response, as 349.[14]

The study was conducted in the antenatal clinic scheduled once a week. From each antenatal clinic, the first 10 pregnant women who were willing to participate, and met the inclusion and exclusion criteria were selected for the study. Written and informed consent was obtained from all the participants who were subsequently interviewed using a pre-tested interview schedule. The participants were appropriately instructed on the procedure for providing a clean catch freshly voided midstream urine sample (10 ml) in a properly labeled wide-mouthed sterile plastic container. These urine samples were transported in an ice box at a temperature of 2-8°C to the urine culture laboratory on the same day within 4 hours of collection where they were processed for a semi-quantitative culture on plated Mac Conkey and Blood agar using a calibrated loop holding 0.001 ml urine volume with further incubation for 24 hours at 37°C. The plates were examined after 24 hours for bacterial growth and reported as no growth, insignificant or significant growth based on colony forming units (CFUs) per ml as per Kass criteria.[21]

The isolates were identified using colony characteristics, gram staining morphology, and standard biochemical tests. According to the bacteria isolated, antibiotic susceptibility testing was done on Muller Hinton agar (HiMedia) using the modified Stokes' disc diffusion method, which is simple, practical, and well-standardized.[22] Twenty-three different antibiotic discs of HiMedia were indented [Table 1]. The antibiotics tested for gram negative bacilli were ampicillin, ceftriaxone, amikacin, piperacillin/tazobactam, cotrimoxazole, nitrofurantoin, gentamicin, imipenem, meropenem, levofloxacin, and colistin. Extended spectrum beta-lactamases (ESBL) production was tested using ceftazidime/clavulanic acid.[23]

For *Staphylococcus*, the antibiotics tested were penicillin, cefoxitin, nitrofurantoin, amikacin, ceftriaxone, cotrimoxazole, norfloxacin, vancomycin, linezolid, and levofloxacin. The antibiotics tested for *Enterococcus* were penicillin, ampicillin, high-content gentamicin, nitrofurantoin, ciprofloxacin, vancomycin, linezolid, levofloxacin, teicoplanin, and for *Pseudomonas* were ceftazidime, gentamicin, meropenem, ciprofloxacin, piperacillin, piperacillin/tazobactam, imipenem, amikacin, levofloxacin, netilmicin, and colistin were tested for susceptibility. The quality controls used were *Staphylococcus aureus* NCTC 6571, *Escherichia coli* NCTC 10418, *Pseudomonas aeruginosa* NCTC 10662. The results were interpreted using standard disc diffusion interpretative criteria into sensitive, intermediate, or resistant.[22]

Operational definitions

Symptoms of UTIs: A pregnant woman was said to have symptoms of UTI when she had one or more of the following symptoms based on history: increased frequency and urgency of micturition, burning micturition, painful micturition, lower abdominal pain, and backache.

1. Asymptomatic bacteriuria: A woman was said to have asymptomatic bacteriuria when none of the symptoms of UTI were present and the colony count in a single culture was $\geq 10^5$ CFU/ml.
2. Symptomatic bacteriuria: A woman was said to have symptomatic bacteriuria when any symptom of UTI was present, and the colony count in a single culture was $\geq 10^3$ CFU/ml.[24]
3. UTI: A woman was said to have UTI on either asymptomatic bacteriuria or the presence of symptomatic bacteriuria is present.
4. Contamination was considered mixed growth of 3 or more organisms after 24 hours of incubation.
5. Modified Kuppuswamy socio-economic scale updated for 2019 was used for assessment of the socio-economic status of the family of the subjects.[25]
6. Growth on urine culture examination: A urine sample was said to have growth on urine culture examination when there was any visible growth by the naked eye after 24 hours of incubation on Mac Conkey agar or blood agar regardless of colony count.
7. Significant growth: The growth on urine culture examination was said to be significant when the colony count in a single culture after 24 hours of incubation on Mac Conkey agar or blood agar was $\geq 10^5$ CFU/ml.
8. Insignificant growth: The growth on urine culture examination was said to be insignificant when the colony count in a single culture after 24 hours of incubation on Mac Conkey agar or blood agar was $\geq 10^3$ to $<10^5$ CFU/ml.

Statistical analysis

Data were analyzed with IBM SPSS Version 25 (Armonk, NY: IBM Corp.). Data regarding pregnant women suffering from symptomatic and asymptomatic UTI was expressed in frequency and 95% CIs. Data regarding causative organisms isolated and their antibiotic resistance were expressed in frequency and proportions. Continuous variables were reported as median and interquartile range. The association of sociodemographic and other factors with the presence of UTI was done by using the Chi-square test or Fisher's exact test. Multivariable regression analysis was done to find the independent predictors of UTI. All the characteristics associated with UTI having a $P < 0.1$ in the bivariate analysis were included in a binary logistic regression model. The adjusted odds ratio (aOR) with 95% CI was reported for all the variables included in the model. $P < 0.05$ was considered statistically significant.

Ethical considerations: The study was approved by the Institutional Ethics Committee. Written and informed consent was provided by all the participants. All women with UTI infection were provided appropriate medical treatment and referral services by a clinical healthcare provider.

Table 1: Antibiotics with their disc concentration

Antibiotic	Disc concentration (in mcg)	Antibiotic	Disc concentration (in mcg)
Ampicillin	10	Linezolid	30
Amikacin	30	Levofloxacin	5
Ceftriaxone	30	Meropenem	10
Ceftazidime	30	Netilmicin	30
Ceftazidime/clavulanic acid	30/10	Nitrofurantoin	300
Cefoxitin	30	Norfloxacin	10
Ciprofloxacin	5	Penicillin	10 units
Colistin	10	Piperacillin	100
Cotrimoxazole (Sulphamethoxazole/Trimethoprim)	25 (23.75/1.25)	Piperacillin/Tazobactam	100/10
Gentamicin	10	Teicoplanin	30
High content Gentamicin	120	Vancomycin	30
Imipenem	10		

Results

The urine samples were collected from 348 women, of which 22 samples showed evidence of contamination, and so, a total of 322 samples were analyzed [Figure 1]. The median (IQR) age of the pregnant women was 25 (23-28) years, ranging from 18 to 40 years (*N* = 322). The majority of the participants (80.4%) were in the age group of 20-29 years and most (92.3%) had received some form of formal education (primary school to postgraduation). Only 14 participants (4.3%) were occupied in unskilled, semi-skilled, skilled, and semi-professional work, while most (95.7%) were housewives. The sociodemographic characteristics of the participants are reported in Table 2.

At least one symptom related to UTI was reported by 35.7% (95% CI: 30.7-41.1) of the participants. The most common symptoms reported by the subjects were increased frequency and urgency of micturition [16.8% (95% CI: 13.1-21.2)], burning micturition [12.7% (95% CI: 9.5-16.8)], lower abdominal pain [12.4% (95% CI: 9.3-16.5)], backache [8.7% (95% CI: 6.1-12.3)], and painful micturition 7.8% (95% CI: 5.3-11.2). Most of the participants (92%) showed no visible growth on urine culture after 24 hours of incubation. Two samples (0.6%) showed insignificant growth with a colony count $<10^5$ CFU/ml. The proportion of subjects found to have significant bacteriuria with colony count $\geq 10^5$ CFU/ml was 7.4% (95% CI: 5.1-10.8).

Prevalence and predictors of UTI in pregnant women

The frequency and proportion of pregnant women found to have UTI diagnosed in the presence of significant growth on urine culture was 24 and 7.4% (95% CI: 5.1-10.8), respectively. Among the total participants with UTI (*N* = 24), 13 (54.2%) and 11 (45.8%) subjects were asymptomatic and symptomatic, respectively. The proportion of asymptomatic bacteriuria was found to be 4.0% (95% CI: 2.4-6.8), while the proportion of symptomatic bacteriuria was found to be 3.4% (95% CI: 1.9-6.0). Among the 115 participants reporting at least one symptom related to UTI, only 11 (9.6%) were found to have UTI; while out of 207 pregnant women who had no symptoms, 13 (6.3%) were found to have UTI. However, the difference between the two was not statistically significant (χ^2 = 1.157, df = 1, *P* = 0.282) [Table 3].

On bivariate analysis, larger family size, shorter duration of marriage, primigravida, inadequate water intake, and sharing of a common toilet with multiple households showed a statistically significant association with the presence of UTI (*P* < 0.05). On binary logistic regression analysis, only

Table 2: Sociodemographic characteristics of the pregnant women (*n*=322)

Characteristic	Frequency (*n*)	Percentage	Characteristic	Frequency (*n*)	Percentage
Age (in years)			Type of family		
≤19	12	3.7	Nuclear	100	31.1
20-24	127	39.4	Joint	222	68.9
25-29	132	41.0	Socioeconomic class		
30-34	46	14.3	Upper (U)	0	0.0
≥35	5	1.6	Upper middle (UM)	29	9.0
Religion			Lower middle (LM)	91	28.3
Hindu	299	86.7	Upper lower (UL)	188	58.4
Muslim	23	13.3	Lower (L)	14	4.3
Residence			Duration of marriage (in years)		
Gokalpuri	108	33.5	<1	72	22.4
Gokalpur Village	33	10.3	1-4	139	43.2
Ganga Vihar	135	41.9	≥5	111	34.4
Sanjay Colony	39	12.1	Gravida		
Others	7	2.2	G1	117	36.3
Education			G2	115	35.7
Illiterate	25	7.7	G3	64	19.9
Primary school	35	10.9	G4 and above	26	8.1
Middle school	53	16.4	Trimester		
High school	72	22.4	First	62	19.3
Intermediate school	50	15.5	Second	203	63
Graduate	81	25.2	Third	57	17.7
Post-graduate	6	1.9			
Occupation					
Housewife	308	95.7			
Unskilled worker	4	1.2			
Semi-skilled worker	3	0.9			
Skilled worker	2	0.6			
Semi-professional	5	1.6			

Table 3: Comparison of UTI-related symptoms and diagnosis of UTI in pregnant women (*n*=322)

Symptoms	UTI#		Total *n* (%)	*P**
	Present *n* (%)	Absent *n* (%)		
Increased frequency and urgency of micturition				
Present	5 (9.3)	49 (90.7)	54 (100.0)	0.572
Absent	19 (7.1)	249 (92.9)	268 (100.0)	
Burning micturition				
Present	4 (9.8)	37 (90.2)	41 (100.0)	0.526
Absent	20 (7.1)	261 (92.9)	281 (100.0)	
Painful micturition				
Present	6 (24.0)	19 (76.0)	25 (100.0)	0.006
Absent	18 (6.1)	279 (93.9)	297 (100.0)	
Lower abdominal pain				
Present	4 (10.0)	36 (90.0)	40 (100.0)	0.518
Absent	20 (7.1)	262 (92.9)	282 (100.0)	
Backache				
Present	2 (7.1)	26 (92.9)	28 (100.0)	1.000
Absent	22 (7.5)	272 (92.5)	294 (100.0)	
Total	24 (7.4)	298 (92.6)	322 (100.0)	

#Culture positive or lab-confirmed UTI. *P value using Fisher's exact test

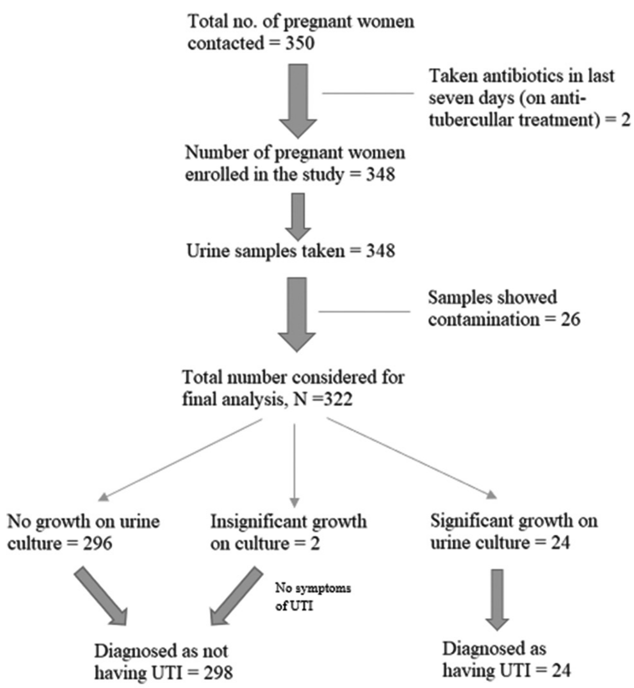

Figure 1: Flow of participants in the study

family size (>10) was a statistically significant predictor of UTI (aOR 5.01 (1.23, 20.44, P = 0.025) [Table 4].

A total of 64 (19.9%) participants reported a history of UTI within the previous 6 months of which 43 (67.2%) took some kind of treatment, while the rest 21 (32.8%) did not take any kind of treatment. Thirty-six participants reported consulting a doctor, three took medication from a pharmacist, two from quacks, and three undertook self-medication. Among the 36 participants who consulted a doctor, 28 (77.7%) completed the course of treatment, while 8 did not complete the treatment on symptomatic improvement. Seven cases of UTI were diagnosed in the participants who provided a past history of UTI, of which five reported consulting a doctor and completing their prescribed treatment.

Organisms isolated on urine culture

Among the positive urine culture cases (n = 24), half of the isolates detected were of *Escherichia coli* (50%), followed by *Klebsiella pneumoniae* in 7 (29.2%), *Staphylococcus aureus* in 3 (12.5%) while *Acinetobacter* species were detected in only 2 (8.3%) isolates. None of the urine samples showed growth of two different bacteria simultaneously on culture.

Antibiotic susceptibility patterns of microorganisms isolated on culture are reported in Table 5. The most common organism isolated on urine culture was *E. coli* in 50% of the cases. Half of the isolates (50%) of *E. coli* were found to be ESBL producers. The second most frequent organism isolated was *Klebsiella pneumoniae* in 7 (29.2%) isolates that were highly sensitive to piperacillin/tazobactam (100%) and meropenem (100%), but all the isolates were resistant to ampicillin. *Acinetobacter* species were the least commonly isolated bacteria on culture isolated in only two samples (8.3%). The only gram-positive bacteria isolated was *Staphylococcus aureus*, detected in three participants with two samples being Methicillin-resistant Staphylococcus aureus (MRSA) (resistant to cefoxitin).

Discussion

The present study observed a relatively low burden of UTI in pregnant women attending an antenatal clinic in a low-income neighborhood in Delhi, although it is higher than the prevalence reported in high-income countries such as the USA (6.0%) and the UAE (4.8%).[26,27] A systematic review of UTI among pregnant women in Africa and Asia from 2005 to 2016 showed an overall prevalence of 13.5%, which is also higher than

Table 4: Distribution of factors associated with urinary tract infection in pregnant women

Characteristic	UTI		Total n (%)	cOR (95% CI), *P*	aOR (95% CI), *P*
	Present *n* (%)	Absent *n* (%)			
Age (in Years)					
≤24	11 (7.9)	128 (92.1)	139 (100.0)	1.12 (0.49, 2.59), *P*=0.784	-
≥25	13 (7.1)	170 (92.9)	183 (100.0)	1	-
Education					
Illiterate	1 (4.0)	24 (96.0)	25 (100.0)	1	-
High school and below	12 (7.5)	148 (92.5)	160 (100.0)	1.94 (0.24, 15.66), *P*=0.531	-
More than high school	11 (8.0)	126 (92.0)	137 (100.0)	2.09 (0.26, 16.99), *P*=0.489	-
Occupation					
Household work	24 (7.8)	284 (92.2)	308 (100.0)	*P*=0.611*	-
Working women	0 (0.0)	14 (100.0)	14 (100.0)	-	-
SES					
Lower (UL&L)	17 (8.4)	185 (91.6)	202 (100.0)	1.48 (0.62, 3.94), *P*=0.394	-
Middle (UM&LM)	7 (5.8)	113 (94.2)	120 (100.0)	1	-
Type of Family					
Joint	21 (9.5)	201 (90.5)	222 (100.0)	3.38 (0.98, 11.60), *P*=0.041	1.87 (0.34, 10.42), *P*=0.476
Nuclear	3 (3.0)	97 (97.0)	100 (100.0)	1	1
Family size					
≤4	7 (5.6)	117 (94.4)	124 (100.0)	0.78 (0.30, 2.02), *P*=0.612	2.05 (0.60, 6.95), *P*=0.250
5-10	13 (7.1)	170 (92.9)	183 (100.0)	1	1
>10	4 (26.7)	11 (73.3)	15 (100.0)	4.76 (1.33, 17.03), *P*=0.017	5.01 (1.23, 20.44), *P*=0.025
Duration of Marriage					
<5 years	21 (9.9)	191 (90.1)	212 (100.0)	3.92 (1.14, 13.45), *P*=0.030	3.38 (0.80, 14.19), *P*=0.097
≥5 years	3 (2.7)	107 (97.3)	110 (100.0)	1	1
Gravida					
1	14 (12.0)	103 (88.0)	117 (100.0)	2.65 (1.14, 6.18), *P*=0.024	1.51 (0.55, 4.17), *P*=0.423
>1	10 (4.9)	195 (95.1)	205 (100.0)	1	1
Past history of UTI					
Present	7 (10.9)	57 (89.1)	64 (100.0)	1.74 (0.69, 4.40), *P*=0.241	-
Absent	17 (6.6)	241 (93.4)	258 (100.0)	1	-
Water intake					
<6 glasses per day	12 (7.3)	153 (92.7)	165 (100.0)	1	-
≥6 glasses per day	12 (7.6)	145 (92.4)	157 (100.0)	1.06 (0.46, 2.42), *P*=0.899	-
Toilet Access					
In house separate	6 (4.0)	143 (96.0)	149 (100.0)	1	1
Sharing with others	18 (10.4)	155 (89.6)	173 (100.0)	2.76 (1.07, 7.17), *P*=0.036	1.50 (0.49, 4.64), *P*=0.479
Type of toilet seat					
Squatting type	19 (6.8)	259 (93.2)	278 (100.0)	1	-
Commode type	5 (11.4)	39 (88.6)	44 (100.0)	1.75 (0.62, 4.95), *P*=0.293	-

**P* value using Fisher exact test; cOR: Crude Odds Ratio; aOR: Adjusted Odds Ratio

the proportion seen in this study. This difference could be because all the 26 studies included in the review were done in hospital settings, while this study was done in a primary care setting.[28] Within India, there is considerable heterogeneity in bacteriuria rates in pregnant women with prevalence estimates varying from 7.3% (Uttar Pradesh) (Sujatha *et al.*),[29] 9.6% (Maharashtra) (Thakre *et al.*),[30] 24% (Rajasthan) (Sabharwal *et al.*),[31] and Telangana (16.8%) (Ansari *et al.*).[32]

In this study, out of the 35.7% of women (115 out of 322) who had reported symptoms related to UTI, only 9.6% of them (11 out of 115) were found to be suffering from UTI, a finding in agreement with a prior study where 93% of women having UTI related symptoms did not have evidence of UTI on culture.[10] The present study also observed women living in large households had significantly higher odds of having UTIs, an observation corroborative of evidence from a study in Saudi Arabia suggestive of common UTI risk factors in compromised personal hygiene.[33] Similarly, a higher proportion of women sharing a common toilet with other households were found at risk of having UTI compared to those utilizing separate toilets, corroborating evidence from a previous case-control study in Cameroon.[34]

The most common organisms in urine culture in this study were *E. coli, Klebsiella pneumoniae, Staphylococcus aureus,* and *Acinetobacter* species (8.3%), findings that are comparable to

Table 5: Antibiotic susceptibility pattern of causative organisms of UTI

Antibiotic	*Escherichia coli* (n=12)			*Klebsiella pneumoniae* (n=7)			*Acinetobacter* species (n=2)			*Staphylococcus* species (n=3)		
	S n (%)	I n (%)	R n (%)	S n (%)	I n (%)	R n (%)	S n (%)	I n (%)	R n (%)	S n (%)	I n (%)	R n (%)
Nitrofurantoin	12 (100)	0 (0.0)	0 (0.0)	5 (71.4)	0 (0.0)	2 (28.6)	2 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (100.0)
Ampicillin	3 (25.0)	0 (0.0)	9 (75.0)	0 (0.0)	0 (0.0)	7 (100)	2 (100)	0 (0.0)	0 (0.0)	1 (33.3)	0 (0.0)	2 (66.7)
Piperacillin + Tazobactam	11 (91.7)	0 (0.0)	1 (8.3)	7 (100)	0 (0.0)	0 (0.0)	2 (100)	0 (0.0)	0 (0.0)	3 (100)	0 (0.0)	0 (0.0)
Cotrimoxazole	5 (41.7)	0 (0.0)	7 (58.3)	3 (42.9)	0 (0.0)	4 (57.1)	0 (0.0)	0 (0.0)	2 (100)	3 (100)	0 (0.0)	0 (0.0)
Amoxicillin + Clavulanic	7 (58.3)	2 (16.7)	3 (25.0)	3 (42.9)	1 (14.2)	3 (42.9)	2 (100)	0 (0.0)	0 (0.0)	2 (66.7)	0 (0.0)	1 (33.3)
Ceftriaxone	4 (33.3)	0 (0.0)	8 (66.7)	5 (71.4)	0 (0.0)	2 (28.6)	1 (50.0)	0 (0.0)	1 (50.0)	2 (66.7)	0 (0.0)	1 (33.3)
Amikacin	9 (75.0)	0 (0.0)	3 (25.0)	5 (71.4)	0 (0.0)	2 (28.6)	2 (100)	0 (0.0)	0 (0.0)	1 (33.3)	0 (0.0)	2 (66.7)
Gentamicin	5 (41.7)	0 (0.0)	7 (58.3)	6 (85.8)	0 (0.0)	1 (14.2)	2 (100)	0 (0.0)	0 (0.0)	3 (100)	0 (0.0)	0 (0.0)
Colistin	1 (8.3)	11 (91.7)	0 (0.0)	2 (28.6)	5 (71.4)	0 (0.0)	1 (50.0)	1 (50.0)	0 (0.0)	3 (100)	0 (0.0)	0 (0.0)
Levofloxacin	6 (50.0)	1 (8.3)	5 (41.7)	5 (71.4)	0 (0.0)	2 (28.6)	2 (100)	0 (0.0)	0 (0.0)	1 (33.3)	1 (33.3)	1 (33.3)
Imipenem	11 (91.7)	0 (0.0)	1 (8.3)	6 (85.8)	0 (0.0)	1 (14.2)	2 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (100)
Meropenem	12 (100)	0 (0.0)	0 (0.0)	7 (100)	0 (0.0)	0 (0.0)	2 (100)	0 (0.0)	0 (0.0)	1 (33.3)	0 (0.0)	2 (66.7)

S: Sensitive; I: Intermediate; R: Resistant

estimates from studies in Africa and Asia.[6] Previous studies from India have also reported on *E. coli* being the most common isolate in urine isolate of pregnant women.[31,35]

Unlike the present study, some other studies have reported various other microbial isolates in pregnant women during routine screening including *Enterococcus faecalis*, coagulase-negative *Staphylococcus*, *Citrobacter, Staphylococcus saprophyticus, Pseudomonas aeruginosa,* and *Proteus mirabilis*. The fewer isolates in this study were perhaps because our study was conducted in a primary care setting which catered to a limited geographic area in a population having similar demographics and health-seeking behavior in contrast to hospital-based settings that manage antenatal patients from diverse geographic and demographic settings.[36,37] Furthermore, the antibiotic susceptibility testing in our study showed that isolates were highly resistant to ampicillin, cotrimoxazole, and ceftriaxone (46%), suggestive of a pattern of increasing antibiotic resistance in the community.

The strengths of the study include the screening for UTI among pregnant women through validated urine culture and sensitivity methods with an adequate sample size and being one of the first studies from India which evaluated the prevalence of UTI at the primary health care facility level. The main study limitation is that it is a single-site study, and the findings cannot be generalized to secondary and tertiary care health facilities that have more diverse sociodemographic and geographic participant profiles. Nevertheless, our study findings are significant since the antenatal women belonged to a low-income neighborhood having limited health facilities with greater vulnerability to unwarranted exposure to oral antibiotics. Another limitation of this study is the detection of susceptibility of colistin was assessed using the disc diffusion method which has been superseded by the broth microdilution method.[38]

In conclusion, the prevalence of laboratory-confirmed UTI among pregnant women attending an antenatal clinic in an urban health facility located in a low-income neighborhood in Delhi was 7.4% with asymptomatic bacteriuria 4.0% and symptomatic bacteriuria constituting 3.4% of the cases with *E. coli, Klebsiella pneumoniae, Staphylococcus aureus*, and *Acinetobacter* species being the most common organisms isolated from urine culture. These study findings indicate the need to raise awareness through effective information, education, and communication campaigns and focus on the active screening for UTI through urine culture and sensitivity irrespective of the presence or absence of UTI-related symptoms in pregnant women living in overcrowded settings and sharing toilets with other households. This would enable the prescription and treatment with appropriate narrow-spectrum antibiotics and avoid unwarranted use of broad-spectrum antibiotics having a likelihood of driving increasing AMR. However, initiation of presumptive antibiotic therapy for UTI in pregnant women in the absence of laboratory confirmation should be restricted to symptoms of painful micturition as most of the other UTI-related symptoms were found to be false positive on laboratory (urine) culture although future multi-centric studies need to be conducted to obtain evidence with greater external validity. The study findings imply that the positive cases of urine culture should be tested for antimicrobial susceptibility. Furthermore, the comparatively safer oral drug in pregnancy to which uropathogens were found to have the least resistance in this study is Nitrofurantoin, hence, whenever, facilities for urine culture and sensitivity are not available, this drug can be considered for the treatment of UTI empirically in comparable settings.

Ethics approval and consent to participate

This study was approved by the Institutional Review Board (IEC/MAMC/70/05/2019/428) and performed in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all the participants.

Availability of data and materials

The datasets will be made available from the corresponding author upon reasonable request.

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Conflicts of interest

There are no conflicts of interest.

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