



Original Research Paper

# Prevalence and Microbiological Profile of Urinary Tract Infection among pregnant women with Preeclampsia and Normotensive : A Retrospective Comparative Study

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## **Abstract**

### Background:

Urinary tract infection (UTI) is one of the most prevalent bacterial infections in pregnancy and considered as a risk factor for adverse maternal outcomes including hypertensive disorders of pregnancy. The relationship of UTI with preeclampsia is unclear, especially in Indian tertiary care settings. Objectives: To determine the prevalence of UTI among women with preeclampsia and normotensive pregnancy and to characterize microbiological profiles of urinary pathogens along with associated factors among those infected.

### Methods:

A retrospective comparative cross-sectional study was conducted in the Department of Obstetrics and Gynaecology, Saveetha Medical College and Hospitals, Chennai. This retrospective study evaluated medical records of 60 pregnant women, including 30 patients with preeclampsia and 30 normotensive pregnant women. A structured proforma was used to extract data from antenatal case records, laboratory reports and urine culture registers. UTI was defined by significant growth on urine culture. Statistical analysis was carried out using the chi-square test, odds ratio (OR) with 95% confidence interval (CI), and binary logistic regression analysis.

### Results:

The overall prevalence of culture-confirmed urinary tract infection was 38.3%, (23/60) among the 60 pregnant women included in the study. Urinary tract infection was found to be more frequent in women with preeclampsia compared to normotensive pregnant women, it is detected in 16 (53.3%) participants and seven (23.3%), respectively ( $\chi^2 = 5.71$ ,  $p = 0.017$ ). Preeclamptic women exhibited an almost four-fold increased risk of urinary tract infection compared to normotensive pregnant women (OR = 3.76; 95% CI: 1.22–11.58). In multivariable binary logistic regression analysis, preeclampsia remained an independent predictor of urinary tract infection after adjusting for maternal age, gravidity and gestational age (Adjusted OR = 3.42; 95% CI: 1.06–11.03;  $p = 0.039$ ). The microbiological assessment showed that the most common urinary pathogen was *Escherichia coli* (43.5% of isolates), followed by *Klebsiella pneumoniae* (26.1%) and *Enterococcus faecalis* (13.0%).

### Conclusion:

The prevalence of UTI was significantly higher in women with preeclampsia than that in normotensive pregnant women. Colonization of UTIs remained an contributing risk factor for preeclampsia and emphasizes the need for routine urine culture screening to be performed when testing for microbiological evaluation in pregnant women with hypertensive disorders so that they can be diagnosed and treated early.

**Keywords:** Preeclampsia; Urinary tract infection; Pregnancy; Urine culture; *Escherichia coli*; Hypertensive disorders of pregnancy.

## **INTRODUCTION**

Urinary tract infection (UTI) is one of the most prevalent bacterial infections during pregnancy and constitutes a major public health concern globally. The physiological and anatomical changes that happen during pregnancy such as ureteric dilatation, urinary stasis and decreased bladder tone favour bacterial colonization and infection. <sup>1</sup> UTIs in pregnancy are asymptomatic; and acute cystitis or

pyelonephritis with significant maternal morbidity if untreated. <sup>2</sup> Thus UTI has been associated with adverse obstetric outcomes besides maternal complications, such as preterm birth, low birth weight and fetal growth restriction in addition to increase perinatal morbidity. <sup>3</sup>

Hypertensive disorders of pregnancy, particularly preeclampsia, continue to be one of the top causes of maternal and perinatal morbidity and mortality throughout the world. Preeclampsia is a multisystem disorder characterized by new-onset hypertension

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and proteinuria or end-organ dysfunction after 20 weeks of gestation.<sup>4</sup> The pathogenesis of preeclampsia is not yet completely elucidated, but abnormal placentation, endothelial dysfunction, systemic inflammation and immune dysregulation all seem to be important in the development of this disorder.<sup>5</sup> The role of maternal infections as mediators of these inflammatory pathways and a modifiable determinant for the risk and severity of preeclampsia is increasingly supported by evidence from other studies.

There are some epidemiological studies between urinary tract infection and preeclampsia during pregnancy. Maternal urinary infections could initiate inflammatory responses and matrix damage to the endothelium, which are well-known reactions of placental depressions in preeclampsia.<sup>6</sup> There have been a limited number of observational studies and systematic reviews showing a high frequency of urinary tract infections in women with preeclampsia compared to normotensive pregnant women, which leads us to hypothesize that there may be an association between these two conditions.<sup>7</sup>

Despite accumulating evidence to suggest a link between urinary tract infection and hypertensive disorders of pregnancy, the literature demonstrates substantial heterogeneity in its reported prevalence across populations and healthcare settings. Such discrepancies may be due to variations in the diagnostic criteria, microbiological methods used, and/or study designs between different regions or countries.<sup>8</sup> Also, limited data are available comparing the prevalence of urinary tract infection in preeclamptic versus nonpre-eclamptic patients directly from Indian tertiary care settings.

The aim of the present study is to determine and compare prevalence of UTI among women with preeclampsia and normotensive pregnancy. Besides estimating the burden of urinary tract infection in both groups, also microbiological profile of urinary pathogens isolated from culture positive cases were compared and selected maternal and obstetric factors associated with urinary tract infection were identified. This study carries out an extensive assessment of the association between preeclampsia and urinary tract infection by analysing urinary tract infection occurrence in association with hypertension state during pregnancy. The results are anticipated to produce reliable evidence on the association between urinary tract infection and hypertensive disorders of pregnancy, and could help inform appropriate screening, early detection and preventive strategies during antenatal care.

#### METHODOLOGY

The present study was carried out as a hospital based retrospective comparative cross-sectional study in the Department of Obstetrics and Gynaecology of Saveetha Medical College and Hospitals, Chennai after getting approval from Institutional Ethics Committee. The study was conducted to evaluate

and compare the prevalence of urinary tract infection (UTI) in women with preeclampsia and normotensive pregnancy. The research involved extracting data from the records of eligible pregnant women which were collected by reviewing hospital medical records, antenatal case sheets, microbiology laboratory reports, urine culture registers and discharge summaries of. The study followed all appropriate ethical guidance and was approved in accordance with institutional ethics standards, with patient information anonymised prior to analysis for confidentiality.

The study population was pregnant women admitted to the Department of Obstetrics and Gynaecology who had urine investigations done during their antenatal or inpatient evaluation. Medical records were reviewed and screened for eligibility using prespecified inclusion and exclusion criteria.

The preeclampsia group included women diagnosed with preeclampsia after defined 20 weeks of gestation with available urine routine examination and urine culture reports. The normotensive group comprised pregnant women diagnosed as not having a hypertensive disorder in pregnancy and who had undergone urine investigations during the same time period. The study excluded samples from women with chronic hypertension established prior to pregnancy, history of chronic renal disease, congenital abnormalities of the urinary tract and/or immunocompromised states; those with multiple gestation whose records were incomplete and those who missed microbiological reports.

A total of 60 participants were included in the study. The study population was divided into two groups:

**Group A (Preeclampsia Group):** Pregnant women diagnosed with preeclampsia (n = 30)

**Group B (Normotensive Pregnancy Group):** Pregnant women without documented hypertensive disorders during pregnancy (n = 30)

The sample size was based on the study of Kaduma et al., showed that there is a significant relationship between urinary tract infection in pregnant women and preeclampsia.<sup>9</sup> From the assumption of population difference from the study reference and access to entire medical records over a study period, we determined a minimal sample size of 27 participants per group. The study size was inflated to achieve 30 participants in each group, totalling 60 women in an attempt to increase statistical power and compensate for the missing data frequently associated with retrospective studies.

The study employed a structured proforma for data extraction. The available records were reviewed for relevant demographic, obstetric, clinical, laboratory, microbiological, maternal and fetal variables. MethodsMaternal variables included age, gravidity, parity, gestational age at admission, blood pressure status (British Hypertension Society classification), proteinuria, associated medical disorders and mode of delivery. Laboratory variables included the

results of urine cultures and microbiological findings in culture-positive urine samples. We extracted information from available laboratory records with patient data regarding presence/absence of urinary tract infection and the type of isolated microorganisms to analyze between study groups.

Prior to the data collection, operational definitions were made for a standard assessment of study variables. Preeclampsia was defined as new-onset after 20 weeks of gestation hypertension with systolic blood pressure  $\geq 140$  mmHg and/or diastolic blood pressure  $\geq 90$  mmHg and/or concomitantly associated with proteinuria and/or evidence of maternal organ dysfunction obtained from the medical records. Normotensive pregnancy was defined as the 1 with absence of documented hypertensive disorder during the antenatal and hospital stays. A urinary tract infection according to the microbiological criteria of the institution was defined as urine culture showing significant growth, usually  $\geq 10^5$  colony-forming units per millilitre of a single pathogenic organism. Symptomatic urinary tract infections and asymptomatic bacteriuria were included when microbiological evidence was available.

Urine routine examination and urine culture reports, available in patient records were used for assessment of urinary tract infection. Whenever cited urine microscopy-searching through pus cells, epithelial cells, bacteria, nitrites and leukocyte esterase was evaluated. Urine culture reports were examined for characterization of pathogenic organisms and antimicrobial susceptibility profiles. Organisms commonly isolated such as *Escherichia coli*, *Klebsiella pneumoniae*, *Enterococcus* species, *Pseudomonas aeruginosa* and other uropathogens were documented and analyzed.

The main outcome was the presence of urinary tract infection among preeclampsia and normotensive pregnancy women. Secondary outcome measures were urine culture positivity between groups, microbiological aspects of urinary pathogens isolated (from culture positive cases), and identification of selected maternal and obstetric factors related to urinary tract infection.

All data extracted were entered into a predesigned Microsoft Excel workbook and subsequently analysed using Statistical Package for Social Sciences (SPSS) software version 26.0. Data are presented as mean  $\pm$  standard deviation for continuous variables and frequencies and percentages for categorical variables. Urinary Tract Infection prevalence was calculated on the individual basis for both study groups. Continuous variables were compared with the Chi-square test or Fisher's exact test wherever appropriate. Independent sample t-test was performed to compare the continuous variables. We calculated odds ratios with 95% confidence intervals in one

sample to evaluate the relationship between urinary tract infection and preeclampsia. Statistical tests with p-value less than 0.05 were considered as statistically significant.

## RESULTS

In this study, a total of 60 pregnant women including 30 preeclampsia and 30 normotensive pregnant women were included. There was no demographic or obstetric difference between the two groups. Mean maternal age in the preeclampsia group was comparable to that in obstetric patients without hypertension ( $27.8 \pm 4.2$  years vs  $26.9 \pm 3.8$  years). Most participants from both groups classified into the age group 25–30 years (50.0% vs 46.7%). The preeclampsia and normotensive groups consisted of multiparous women in 40.0% and 46.7%, respectively, whereas primigravidae represented 60.0% of the study group for those with preeclampsia vs 53.3% for their matched counterparts. Among the women with preeclampsia, the mean gestational age at diagnosis or presentation was  $35.8 \pm 2.4$  weeks and among normotensive pregnant women it was  $36.4 \pm 2.1$  weeks. The demographic and obstetric characteristics were generally comparable, demonstrating sufficient baseline equivalence for comparisons to be done between the groups (Table 1).

**TABLE 1. Baseline Demographic and Obstetric Characteristics of Women with Preeclampsia and Normotensive Pregnancy (n = 60)**

| Variables                                         | Category      | Preeclampsia (n = 30) | Normotensive Pregnancy (n = 30) |
|---------------------------------------------------|---------------|-----------------------|---------------------------------|
| Maternal Age (years)                              | Mean $\pm$ SD | $27.8 \pm 4.2$        | $26.9 \pm 3.8$                  |
|                                                   | <25 years     | 8 (26.7)              | 10 (33.3)                       |
|                                                   | 25–30 years   | 15 (50.0)             | 14 (46.7)                       |
|                                                   | >30 years     | 7 (23.3)              | 6 (20.0)                        |
| Gravidity                                         | Primigravida  | 18 (60.0)             | 16 (53.3)                       |
|                                                   | Multigravida  | 12 (40.0)             | 14 (46.7)                       |
| Gestational Age at Diagnosis/Presentation (weeks) | Mean $\pm$ SD | $35.8 \pm 2.4$        | $36.4 \pm 2.1$                  |
|                                                   | <34 weeks     | 6 (20.0)              | 3 (10.0)                        |
|                                                   | 34–37 weeks   | 15 (50.0)             | 14 (46.7)                       |
|                                                   | >37 weeks     | 9 (30.0)              | 13 (43.3)                       |

|                                 |               |                  |                 |
|---------------------------------|---------------|------------------|-----------------|
| Systolic Blood Pressure (mmHg)  | Mean $\pm$ SD | 152.6 $\pm$ 10.8 | 118.4 $\pm$ 7.2 |
| Diastolic Blood Pressure (mmHg) | Mean $\pm$ SD | 98.7 $\pm$ 8.6   | 74.8 $\pm$ 5.4  |

SD: Standard Deviation.

Urinary tract infection was significantly more prevalent in preeclamptic women compared to normotensive pregnant women. There were 16 (53.3%) culture-positive urinary tract infection in the preeclampsia group, compared with only 7 (23.3%) women identified with bacteriuria in the normotensive group from 439. Univariate analysis confirmed a positive relationship between preeclampsia and urinary tract infection ( $\chi^2 = 5.71$ ;  $p = 0.017$ ). The odds of UTI in women with preeclampsia were 3.76 times higher than those normotensive pregnant women (OR = 3.76; 95% CI: 1.22–11.58,  $<0.01$ ). These results indicate that women with preeclampsia had a substantially increased burden of urinary tract infection (Table 2).

**TABLE 2. Comparison of the Prevalence of Urinary Tract Infection among Women with Preeclampsia and Normotensive Pregnancy**

| Urinary Tract Infection Status | Preeclampsia (n = 30) | Normotensive Pregnancy (n = 30) | $\chi^2$ Value | Odds Ratio (95% CI) | p-value |
|--------------------------------|-----------------------|---------------------------------|----------------|---------------------|---------|
| UTI Positive                   | 16 (53.3%)            | 7 (23.3%)                       | 5.71           | 3.76 (1.2–11.58)    | 0.017*  |
| UTI Negative                   | 14 (46.7%)            | 23 (76.7%)                      |                |                     |         |
| Total                          | 30 (100.0%)           | 30 (100.0%)                     |                |                     |         |

$\chi^2$ : Chi-square test; CI: Confidence Interval.

\*Statistically significant at  $p < 0.05$ .

*Escherichia coli* was the most common uropathogen isolated, comprising 43.5% of culture-positive urinary tract infections among the study population (23 total isolates). *Klebsiella pneumoniae* was the second commonest organism isolated (26.1% isolates). Other organisms included *Enterococcus faecalis* (13.0%), *Pseudomonas aeruginosa* (8.7%), *Staphylococcus aureus* (4.3%) and *Proteus mirabilis* (4.3%).

The distribution of uropathogens was similar between study groups, with *Escherichia coli* the most frequently isolated organism in both preeclamptic and normotensive pregnant women. These data indicate that Gram-negative enteric organisms predominated as causes of urinary tract infection in pregnancy (Table 3).

**TABLE 3. Distribution of Urinary Pathogens among Culture-Positive Participants in the Study Groups (n = 23)**

| Urinary Pathogens             | Preeclampsia Group (n = 16) | Normotensive Pregnancy Group (n = 7) | Total (n = 23) |
|-------------------------------|-----------------------------|--------------------------------------|----------------|
| <i>Escherichia coli</i>       | 7 (43.8%)                   | 3 (42.9%)                            | 10 (43.5%)     |
| <i>Klebsiella pneumoniae</i>  | 4 (25.0%)                   | 2 (28.6%)                            | 6 (26.1%)      |
| <i>Enterococcus faecalis</i>  | 2 (12.5%)                   | 1 (14.3%)                            | 3 (13.0%)      |
| <i>Pseudomonas aeruginosa</i> | 1 (6.3%)                    | 1 (14.3%)                            | 2 (8.7%)       |
| <i>Staphylococcus aureus</i>  | 1 (6.3%)                    | 0 (0.0%)                             | 1 (4.3%)       |
| <i>Proteus mirabilis</i>      | 1 (6.3%)                    | 0 (0.0%)                             | 1 (4.3%)       |
| Total                         | 16 (100.0%)                 | 7 (100.0%)                           | 23 (100.0%)    |

The study used binary logistic regression analysis to determine factors independently associated with urinary tract infection among the respondents. The predictors enrolled in the regression model were preeclampsia within 6h after delivery, more than 30 years of women and babies born with less than 37 weeks of gestation. In univariate analysis, women with preeclampsia were almost four times as likely to have urinary tract infection than normotensive pregnant women (Crude OR = 3.76; 95% CI: 1.22–11.58).

Preeclampsia was found to be an independent risk factor for UTI after adjusting for maternal age, gravidity and gestational age (Adj OR = 3.42; 95%CI:1.06–11.03;  $p = 0.039$ ). Maternal age of more than 30 years, having primigravida and gestational age less than 37 weeks had higher odds of developing urinary tract infection but these did not attain statistical significance after adjustment for confounders (Table 5). In general, preeclampsia was the only independent variable of urinary tract infection among pregnancy and cohort (Table 4).

**TABLE 4. Multivariable Binary Logistic Regression Analysis of Factors Associated with Urinary Tract Infection among Study Participants**

| Variable               | Crude OR (95% CI) | Adjusted OR (95% CI) | p-value |
|------------------------|-------------------|----------------------|---------|
| Preeclampsia           | 3.76 (1.22–11.58) | 3.42 (1.06–11.03)    | 0.039*  |
| Maternal age >30 years | 1.35 (0.38–4.79)  | 1.21 (0.31–4.65)     | 0.781   |
| Primigravida           | 1.48 (0.51–4.31)  | 1.29 (0.41–4.06)     | 0.662   |

|                           |                  |                  |       |
|---------------------------|------------------|------------------|-------|
| Gestational age <37 weeks | 1.82 (0.63–5.29) | 1.61 (0.51–5.07) | 0.414 |
|---------------------------|------------------|------------------|-------|

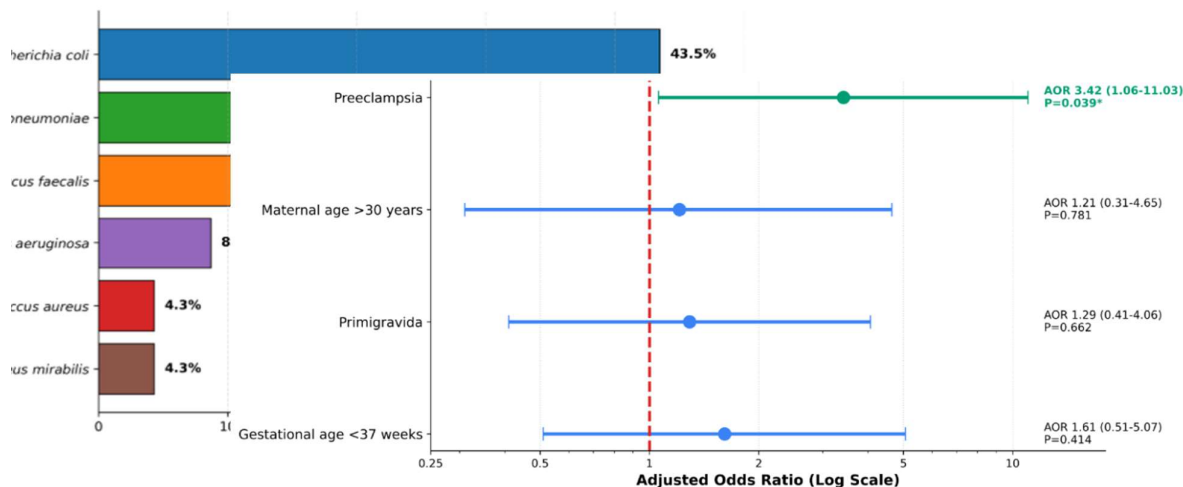
OR: Odds Ratio; CI: Confidence Interval.  
\*Statistically significant at  $p < 0.05$ .

The current study found a markedly greater incidence of UTI in the preeclampsia group as compared to normotensive pregnant women. As anticipated, *Escherichia coli* was the most common pathogen isolated in culture-positive urinary tract infections, consistent with the well-established microbiological characterization of infectious upper urinary tract pathology seen during pregnancy.

On multivariable logistic regression analysis, UTI was found to be a contributing factor for preeclampsia. The results indicate that women with preeclampsia represent a high-risk category for UTIs, and periodical vigilance and early microbiological assessment in these women might be beneficial during prenatal monitoring. Priority attention is needed to identify the early urinary tract infection in this population and undertake timely management, which can prevent adverse maternal and perinatal outcomes.

#### DISCUSSION

The present study identified the burden of urinary tract infection was found to be significantly greater among women with fetal growth restriction than in normotensive pregnant women. Culture-confirmed urinary tract infection was found in 53.3% of women with preeclampsia compared with 23.3% of normotensive pregnant women. UTI can worsen and mask early diagnosis. Women with preeclampsia also had a significantly higher odds of urinary tract infection than those without and this relationship remained significant after adjustment for maternal age, gravidity and gestational age. In



*Figure 1-Distribution of Urinary Pathogens among Culture-Positive Participants (n = 23)*

**Figure 2-Independent Predictors of Urinary Tract Infection among Women with Preeclampsia and Normotensive Pregnancy**

microbiological analysis, *Escherichia coli* (43.5%) and *Klebsiella pneumoniae* (26.1%) accounted for the majority of urinary isolates confirming the known role of gram-negative enteric organisms as principal pathogens in urinary tract infections during pregnancy. These combined findings indicate a notable relationship of pre-eclampsia with urinary tract infection and reinforce the need for appropriate screening and microbiological evaluation of women presenting with hypertensive disorders of pregnancy.

The higher frequency of urinary tract infection in the present study patients with preeclampsia is consistent with prior evidence of an association between urinary infection and hypertensive disorders of pregnancy. Taghavi Zahedkalaei et al. noted the association of urinary tract infection in first trimester with a higher risk of preeclampsia, raising the question that the presence of any urinary infection may possibly lead to hypertensive complications in pregnancy.<sup>10</sup>

The link between UTI and preeclampsia may be biologically plausible, but the true direction of causation is unclear. Karmon and Sheiner said the relationship may also be causal, confounded or partly mediated by other maternal risk factors, cautioning against overinterpretation of this link. Infection-induced inflammatory responses may also play a role in the endothelial dysfunction, oxidative stress, and systemic vascular changes that are key mechanisms in the pathogenesis of preeclampsia.<sup>11</sup> *Escherichia coli* was the most commonly assessed organism in isolation, while *Klebsiella pneumoniae* followed at this research. This finding follows the approach used in a systematic review and meta-analysis by de Souza et al. where *Escherichia coli* was found to be the most common isolated bacterium among pregnant women with urinary tract infection and *Klebsiella* species were identified at second place.<sup>12</sup> The overall distribution of gram-negative enteric organisms in the present study is consistent with the previously established microbiological profile of urinary tract infection during pregnancy.

The dominance of *Escherichia coli* can be attributed to uropathogenic potential, the property for colonization of the urogenital tract and ability to adhere to uroepithelial surfaces. Boutouchent et al. described *E. coli* as the most prevalent causal element of bacteriuria in pregnancy and reported its association with urogenital colonization and asymptomatic bacteriuria. This is in keeping with our present study finding that amongst the isolates, *E. coli* continued to be the most common isolate among both preeclamptic and normotensive pregnant women.<sup>13</sup>

Using multivariable binary logistic regression analysis, this study found that, UTI was found to be a contributing factor for pre-eclampsia. The authors conclude that maternal age greater than 30 years,

primigravida status and gestational age less than 37 weeks increased the odds of urinary tract infection but were not statistically significant. This was evident in the systematic review and meta-analysis performed by Getaneh et al. reported that the  $\geq 2$  previous pregnancies and/or urinary infection during two previous pregnancies were maternal risk factors when assigned to U), confirming as expected the multifactorial origin of the urinary infection risk in pregnancy.<sup>14</sup>

The clinical significance of these findings is that early detection of urinary tract infection in women with hypertensive disorders of pregnancy is essential. In particular, the American College of Obstetricians and Gynecologists recommends screening for asymptomatic bacteriuria with urine culture in the early prenatal care visit and states that diagnosis and treatment of urinary tract infections during pregnancy will reduce maternal and obstetric complications.<sup>15</sup> In the current study, the observation of a higher prevalence of UTI in women with preeclampsia probably reinforces that urine culture investigation in this group should be performed keeping a low threshold.

Strengths of the present study include a comparative design and equal representation in terms of women with preeclampsia versus normotensive pregnancy, and use of the culture-confirmed urinary tract infection as our primary outcome. It also assessed the microbiological profile of urinary pathogens and carried out multivariable binary logistic regression analysis to determine factors that were independently associated with urinary tract infection. These components narrow down the evaluation of the association that preeclampsia had an impact on urinary tract infection.

However, certain limitations deserve acknowledgment. Although the analyses included a number of clinical and laboratory variables, some factors, such as results of urine routine findings and antimicrobial susceptibility patterns were limited due to the retrospective design. The study limited itself to a single tertiary care center and was done with relatively small sample size, which may limit its generalizability. Moreover, maternal and neonatal outcomes were not evaluated in depth. Piazzolla et al. reported that in pregnancy significant bacteriuria is associated with adverse outcomes (such as preterm delivery or low birth weight) but stated the limitations of available evidence are poor quality.<sup>16</sup> Larger multicentric studies with comprehensive microbiological, antimicrobial susceptibility and pregnancy outcome data are also recommended to provide a more definitive statement on urinary tract infection and preeclampsia.

## CONCLUSION

The present study the incidence of urinary tract infection was significantly higher in preeclamptic

women compared with normotensive pregnant women. UTI was found to be a contributing factor for pre-eclampsia, and *Escherichia coli* still remained the most frequent isolated urinary pathogen. Conclusion: The results underscore the need for routine screening and microbiological assessment for urinary tract infection among women with hypertensive disorders of pregnancy. Our results suggest that the early detection of urinary tract infection (UTI) followed by appropriate treatment strategies, would also reduce this burden and improve health outcomes during pregnancy, when included in antenatal care.

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