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ORIGINAL ARTICLE

Diagnostic Accuracy of Combined Leukocyte Esterase and Nitrite Dipstick Testing for Culture-Confirmed Urinary Tract Infection in Symptomatic Pregnant Women

Sultana T[1], Akhther MH[2], Mahamuduzzaman ASM[3], Shireen F[4], Parvin MR[5]

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ABSTRACT

Background: Urinary tract infection is common during pregnancy and may cause significant maternal and fetal complications. Although urine culture is the diagnostic reference standard, dipstick testing offers a rapid and inexpensive alternative.

Aim of the study: This study aimed to determine the diagnostic accuracy of combined leukocyte esterase and nitrite dipstick testing for culture-confirmed UTI among symptomatic pregnant women.

Methods: This cross-sectional descriptive study included 105 symptomatic pregnant women consecutively enrolled at Shaheed Ziaur Rahman Medical College Hospital, Bogura, Bangladesh from January 2025 to December 2025. Clean-catch midstream urine samples were tested by dipstick for leukocyte esterase and nitrite and compared with urine culture (considered as gold standard test) as the reference standard. Data were analyzed using SPSS; diagnostic performance was assessed using sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy with 95% confidence intervals.

Results: Among the 105 participants, 87.6% were younger than 25 years. The mean gravidity was 1.64 ± 0.85, while the mean gestational age was 24.67 ± 4.79 weeks. Culture-confirmed UTI was identified in 7 of 105 participants (6.7%), and Escherichia coli was isolated in all culture-positive cases. Combined leukocyte esterase and nitrite dipstick testing showed 85.7% sensitivity, 98.0% specificity, 75.0% positive predictive value, 99.0% negative predictive value, and 97.1% overall diagnostic accuracy.

Conclusion: Combined leukocyte esterase and nitrite dipstick testing showed high diagnostic accuracy. They may serve as a rapid, low-cost screening tool for UTI in symptomatic pregnant women, although urine culture remains essential for confirmation.

Keywords: Urinary tract infection; Pregnancy; Leukocyte esterase; Nitrite dipstick; and Diagnostic accuracy

INTRODUCTION

Urinary tract infection (UTI) is among the most frequent bacterial infections encountered during pregnancy and encompasses asymptomatic bacteriuria, acute cystitis, and pyelonephritis. During pregnancy, progesterone-mediated smooth-muscle relaxation, ureteral dilatation, urinary stasis, increased bladder capacity, and mechanical compression by the enlarging uterus facilitate bacterial colonization and ascending infection [1,2]. Physiological urinary frequency and lower abdominal discomfort may also overlap with symptoms of infection, making clinical diagnosis particularly challenging in pregnant women [3]. Consequently, accurate and timely identification of UTI remains an important component of antenatal care. Globally, the burden of UTI during pregnancy varies considerably according to population characteristics, diagnostic criteria, healthcare setting, and geographical region. Reported prevalence estimates range from

1. Touhida Sultana, Associate Professor, Department of Obstetrics & Gynaecology, Shaheed Ziaur Rahman Medical College Hospital, Bogura, Bangladesh, E-mail: sheemabogra@gmail.com, Mobile No: 01711109481.
2. Mst. Hasina Akhther, Associate Professor, Department of Obstetrics & Gynaecology, Shaheed Ziaur Rahman Medical College Hospital, Bogura, Bangladesh
3. Abu Shoyeb Md. Mahamuduzzaman, [3]Associate Professor, Department of Pediatrics, Shaheed Suhrawardy Medical College & Hospital, Dhaka, Bangladesh.
4. Fahmida Shireen, Assistant Professor, Department of Obstetrics & Gynaecology, Shaheed Ziaur Rahman Medical College Hospital, Bogura, Bangladesh
5. Most. Runa Parvin, Assistant Professor, Department of Obstetrics & Gynaecology, Shaheed Ziaur Rahman Medical College Hospital, Bogura, Bangladesh
* Address for Correspondence.

approximately 2% to 15% for different forms of pregnancy-associated UTI, while substantial regional variation has been observed [1,4]. In Ethiopia, a systematic review reported a pooled UTI prevalence of 15.37% among pregnant women, whereas a recent Indian meta-analysis estimated asymptomatic bacteriuria at 13.5% [4], [5]. Across Latin America, pooled prevalences of asymptomatic bacteriuria, lower UTI, and pyelonephritis were 18.45%, 7.54%, and 2.34%, respectively [6]. Similarly, a study from Somaliland documented culture-confirmed UTI in 16.4% of pregnant women [7]. Within Bangladesh, pregnancy-associated UTI represents an important clinical problem, particularly where access to microbiological diagnosis is constrained. In a large population-based study involving 4,242 pregnant women in rural Sylhet, an overall UTI prevalence of 8.9% was identified, comprising 4.4% symptomatic UTI and 4.5% asymptomatic bacteriuria [8]. *Escherichia coli* remains the predominant uropathogen in Bangladesh and internationally, while increasing antimicrobial resistance further emphasizes the importance of accurate diagnosis before treatment [8,9]. Clinically, failure to identify and appropriately manage UTI during pregnancy may have important maternal and fetal consequences. Associations have been reported with pyelonephritis, maternal sepsis, anemia, pre-eclampsia, low birth weight, and preterm birth [4,10]. In a recent meta-analysis involving approximately 2.9 million pregnant women, maternal UTI was associated with nearly twice the odds of preterm birth, with a pooled odds ratio of 1.92 [10]. Evidence from systematic reviews also indicates that treatment of confirmed bacteriuria reduces the subsequent risk of pyelonephritis and may decrease low-birth-weight outcomes [11]. Although urine culture remains the reference standard for diagnosing UTI, its routine use may be limited by laboratory requirements, cost, and the time needed to obtain results. In contrast, urine dipstick testing for leukocyte esterase and nitrite provides a rapid, inexpensive, and readily available bedside assessment. However, diagnostic performance varies substantially. A recent study among pregnant women reported sensitivities of 75.5% for leukocyte esterase and 72.0% for nitrite, while concurrent positivity increased specificity but reduced sensitivity [3]. Another investigation in a resource-limited African setting demonstrated that dipstick performance varied depending on whether leukocyte esterase and nitrite were interpreted individually or in combination [12]. Despite its potential usefulness, evidence regarding the diagnostic accuracy of combined leukocyte esterase and nitrite testing specifically among symptomatic pregnant women remains limited, particularly in Bangladesh. Differences in UTI prevalence, pathogen distribution, laboratory facilities, and patient characteristics may influence predictive values and limit direct application of findings from other populations. Therefore, evaluating a rapid and inexpensive dipstick approach against urine culture may provide clinically relevant evidence for settings where immediate microbiological confirmation is difficult. Accordingly, this study aimed to determine the diagnostic accuracy of combined leukocyte esterase and nitrite dipstick testing for detecting culture-confirmed UTI among symptomatic pregnant women attending a tertiary-care hospital in Bangladesh.

MATERIAL AND METHODS

This cross-sectional study was conducted in the Department of Obstetrics and Gynecology Shaheed Ziaur Rahman Medical College Hospital, Bogura, Bangladesh, from January 2025 to December 2025. The study population comprised pregnant women attending the department with clinical features suggestive of urinary tract infection (UTI). A total of 105 eligible participants were consecutively enrolled during the study period. Pregnant women presenting with one or more urinary or associated symptoms, including dysuria, increased frequency of micturition, loin pain, pyrexia, nausea, vomiting, or non-specific lower abdominal pain, were included. Women with vaginal bleeding or spontaneous rupture of membranes were excluded because of the possibility of urine sample contamination. Pregnant women without urinary symptoms, catheterized patients, and those receiving antibiotics at the time of enrolment were also excluded. After enrolment, demographic information, obstetric characteristics, relevant medical history, and presenting clinical features were recorded using a structured data collection form. A freshly voided clean-catch midstream urine specimen was collected from each participant using a sterile container under appropriate instructions to minimize contamination. Urine samples were subjected to dipstick analysis for leukocyte esterase, nitrite, protein, and blood. For the primary diagnostic assessment, combined leukocyte esterase and nitrite positivity was evaluated against urine culture. Urine culture and antimicrobial susceptibility testing were performed according to routine laboratory procedures, with culture considered the reference standard for UTI confirmation. Organisms isolated from culture-positive samples were identified, and their antimicrobial sensitivity patterns were recorded. Data were checked for completeness, entered, and analyzed using SPSS (V. 15). Continuous variables were summarized as mean ± standard deviation, median, and range, where applicable, while categorical variables were presented as frequencies and percentages. A 2 × 2 contingency table was constructed to compare combined dipstick findings with urine culture results. Diagnostic performance was assessed by calculating

sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy, with 95% confidence intervals. Ethical approval was obtained from the relevant institutional authority before commencement of the study. Informed consent was obtained from all participants, and confidentiality and privacy of participant information were maintained throughout the study.

RESULTS

Among the 105 participants, 87.6% were younger than 25 years. The mean gravidity was 1.64 ± 0.85, while the mean gestational age was 24.67 ± 4.79 weeks.

Table 1. Demographic and obstetric characteristics of the study participants (N=105)

Variables	Categories	n (%) / Mean ± SD
Age	<25 years	92 (87.6)
	>25 years	13 (12.4)
Gravidity	Mean ± SD	1.64 ± 0.85
Gestational age (weeks)	Mean ± SD	24.67 ± 4.79

Among participants with a relevant medical history, hypertension was most common (80.0%), followed by previous UTI (40.0%). Regarding presenting complaints, frequency of urination (98.1%), nausea (96.2%), and burning sensation (71.4%), were the predominant symptoms.

Table 2. Medical history and presenting complaints of the study participants

Characteristics	n (%)
Medical history (n=15)	
Hypertension	12 (80.0)
Past history of UTI	6 (40.0)
Diabetes mellitus	2 (13.3)
Presenting complaints (N=105)	
Frequency of urination	103 (98.1)
Nausea	101 (96.2)
Burning sensation	75 (71.4)
Vomiting	72 (68.6)
Pain in lower abdomen	39 (37.1)
Fever	8 (7.6)
Loin pain	2 (1.9)

Among the 55 participants undergoing dipstick analysis, leukocyte esterase was positive in 67.2%, protein in 65.5%, blood in 27.3%, and nitrite in 14.5%. Concurrent positivity for both nitrite and leukocyte esterase were observed in 14.5%.

Table 3. Urine dipstick findings among the study participants undergoing dipstick analysis (n=55)

Dipstick finding	n (%)
Positive for leukocyte esterase	37 (67.2)
Positive for protein	36 (65.5)
Positive for blood	15 (27.3)
Positive for nitrite	8 (14.5)
Positive for both nitrite and leukocyte esterase	8 (14.5)

Of the 105 urine cultures, bacterial growth was detected in 7, 6.7%, while 98, 93.3%, showed no growth. Among all culture-positive samples, *Escherichia coli* was isolated in 100.0%.

Table 4. Urine culture findings and bacterial isolates among the study participants (N=105)

Culture findings	n (%)
No growth	98 (93.3)
Growth	7 (6.7)
Organism among culture-positive samples (n=7)	
Escherichia coli	7 (100.0)

Compared with urine culture, combined leukocyte esterase and nitrite dipstick testing identified 6 of 7 culture-positive cases (85.7%), while 96 of 98 culture-negative cases (98.0%), had negative dipstick results. Only one false-negative and two false-positive results were observed.

Table 5. Comparison of combined leukocyte esterase and nitrite dipstick testing with urine culture for diagnosis of UTI (N=105)

Combined dipstick result	Culture positive	Culture negative	Total
Positive	6 (85.7)	2 (2.0)	8 (7.6)
Negative	1 (14.3)	96 (98.0)	97 (92.4)
Total	**7 (100.0)**	**98 (100.0)**	**105 (100.0)**

Based on urine culture as the reference standard, combined dipstick testing showed 85.7% sensitivity, 98.0% specificity, 75.0% positive predictive value, and 99.0% negative predictive value. The overall diagnostic accuracy was 97.1%.

Table 6. Diagnostic performance of combined leukocyte esterase and nitrite dipstick testing for culture-confirmed UTI (N=105)

Diagnostic parameter	Value (%)	95% CI
Sensitivity	85.7	48.7–97.4
Specificity	98	92.9–99.4
Positive predictive value	75	40.9–92.9
Negative predictive value	99	94.4–99.8
Accuracy	97.1	91.9–99.0

DISCUSSION

In this cross-sectional study of symptomatic pregnant women, culture-confirmed UTI was identified in 6.7%, while combined leukocyte esterase and nitrite dipstick testing showed 85.7% sensitivity, 98.0% specificity, 75.0% positive predictive value (PPV), 99.0% negative predictive value (NPV), and 97.1% accuracy. Although urinary frequency (98.1%), nausea (96.2%), and burning sensation (71.4%) were common, only seven cultures were positive, emphasizing that pregnancy-related physiological symptoms may resemble UTI and cannot reliably establish infection [3,13].

Compared with recent pregnancy cohorts, the 6.7% culture positivity was close to 6.8% reported by the study by Werter et al. 7.8% by Tula et al, 5.3% by Totadhri et al. and 4.0% among symptomatic Ugandan women [3], [14],[15],[13]. In rural Bangladesh, the study by Lee et al. reported 8.9% overall UTI, including 4.4% symptomatic infection and 4.5% asymptomatic bacteriuria [8]. Higher prevalences were reported in Somaliland (16.4%) Indonesia (10.5%) Kenya (21.5%) Cameroon (31.0%) and another Ugandan symptomatic cohort (35.0%) [7], [16], [17], [18], [19]. Across meta-analyses, pooled asymptomatic bacteriuria was 11.1% in Africa and 13.5% in India [12],[5]. Such variation likely reflects symptom-based versus universal antenatal sampling, culture thresholds, gestational age, previous antimicrobial exposure, population risk profiles, and laboratory procedures.

Among the seven positive cultures, *Escherichia coli* accounted for 100.0%, confirming its dominant etiological role, although this proportion exceeded that reported in most studies. In Bangladesh, the study by Lee et al. identified *E. coli* in 38% of isolates, compared with 47.8% in southern Ethiopia, 43.5% in Somaliland, 43.2% in Cameroon, 39.2% in India, and 26.7% in Indonesia [8], [14], [7], [18], [20], [16]. Across Latin America, a meta-analysis estimated approximately 70%, whereas an African meta-analysis reported 33.4% [6][21]. Given only seven positive cultures, the complete predominance observed here may reflect the small number of isolates rather than a genuinely narrower bacterial spectrum.

Regarding dipstick performance, the present sensitivity of 85.7% and specificity of 98.0% were stronger than several contemporary estimates. In the pregnancy cohort by Werter et al., leukocyte esterase had 75.5% sensitivity and 40.4% specificity, nitrite had 72.0% sensitivity and 73.4% specificity, and requiring both tests to be positive yielded 52.0% sensitivity and 82.7% specificity [3]. In Cameroon, the study by Ngong et al. reported 100% specificity for nitrite, whereas leukocyte esterase sensitivity and specificity were 48.3% and 44.9%, respectively [18]. In Kenyan hospital patients, the study by Maina et al. reported 63.1% sensitivity for combined leukocyte esterase and nitrite, while nitrite alone had 89.8% specificity and 97.4% NPV [22]. Among asymptomatic pregnant women, the study by O'Leary et al. found at least one positive dipstick finding in 37.0%, despite only 10.0% having a single-organism positive culture [23]. Across settings, variability may arise from different definitions of positivity, reagent characteristics, urine dwell time, bacterial species, culture cut-offs, and baseline prevalence. Moreover, only seven culture-positive cases in the present study produced a wide sensitivity confidence interval of 48.7–97.4%.

Clinically, the 99.0% NPV suggests that a negative combined dipstick could be useful for rapid exclusion of UTI in similar low-prevalence symptomatic populations, whereas the 75.0% PPV indicates that one in four positive tests may remain culture negative. In Uganda, the study by Sekikubo et al. found culture-confirmed UTI in only 4% of symptomatic pregnant women, highlighting the risk of antibiotic overuse when symptoms alone trigger therapy [13]. In Indonesia, the study by Rosana et al. similarly emphasized culture confirmation when dipstick findings are used to guide treatment [16]. Because predictive values depend strongly on disease prevalence, the high NPV found here should not be generalized directly to higher-prevalence settings.

Regarding participant characteristics, 87.6% were younger than 25 years and mean gestational age was 24.67 weeks. In Kenya, the study by Ayoyi et al. reported a comparable mean maternal age of 24.3 years [17], while 43.7% of asymptomatic bacteriuria cases in an Indian cohort occurred during the second trimester [20]. Among participants with relevant medical histories (40.0% had previous UTI), although no causal association can be inferred from these descriptive data. Elsewhere, previous UTI increased the odds of infection in Somaliland (OR 3.73) [7], and Mexico (OR 4.05) [24].

LIMITATIONS OF THE STUDY:

The study was limited by its relatively small sample size, single-center design, and the small number of culture-positive cases, which reduced the precision of diagnostic accuracy estimates. In addition, dipstick analysis was not available for all participants, and the findings may therefore have limited generalizability to other populations and healthcare settings.

CONCLUSION

Combined leukocyte esterase and nitrite dipstick testing demonstrated high specificity, negative predictive value, and overall diagnostic accuracy for detecting culture-confirmed urinary tract infection among symptomatic pregnant women. The test may therefore serve as a rapid and

inexpensive screening tool, particularly for ruling out UTI in resource-limited settings. However, because false-negative and false-positive results can occur, urine culture should remain the reference standard for diagnostic confirmation and appropriate antimicrobial management during pregnancy.

RECOMMENDATIONS

Combined leukocyte esterase and nitrite dipstick testing may be used as a rapid, low-cost initial screening method for suspected UTI in symptomatic pregnant women, especially where immediate culture facilities are limited. However, urine culture should be performed whenever feasible, particularly in women with positive dipstick findings, persistent symptoms, recurrent UTI, or high clinical suspicion. Larger prospective multicenter studies are recommended to validate the diagnostic performance of combined dipstick testing in diverse pregnant populations.

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