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A Comparison of Urine Dipstick Test with Spot Urine Protein–Creatinine Ratio and 24-Hour Protein Excretion in Women with Pre-Eclampsia

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ABSTRACT

Pre-eclampsia is a major obstetric complication marked by hypertension and significant proteinuria after 20 weeks of gestation, posing serious maternal and fetal risks. Early and accurate detection is critical for effective management. **Objectives:** To assess the diagnostic accuracy, sensitivity, and specificity of the spot urine protein–creatinine ratio (UPCR) in detecting significant proteinuria in pre-eclamptic women, compared to 24-hour urine protein excretion. **Methods:** A cross-sectional study was conducted in the Department of Obstetrics and Gynaecology, Tertiary Care Hospital, Bahawalpur, from November 24, 2022, to May 23, 2023 (Approval No. 1516/Trg/2022). The study included 202 pregnant women diagnosed with pre-eclampsia. Spot UPCR and 24-hour urine protein were measured, and dipstick testing was performed. A UPCR cutoff of 0.3 was used to evaluate diagnostic accuracy. **Results:** The mean UPCR was 1.47 ± 1.05 mg/g, and the mean 24-hour urine protein excretion was 1475.35 ± 1099.87. mg. Spot UPCR showed a strong correlation with 24-hour urine protein ($r = 0.974$, $p<0.001$). ROC analysis revealed an AUC of 0.971. At the 0.3 cutoff, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were 84.2%, 83.3%, 98.8%, and 25.0%, respectively. **Conclusions:** It was concluded that spot UPCR is a reliable and efficient alternative to 24-hour urine collection for detecting significant proteinuria in pre-eclampsia. Its integration into routine antenatal care may enhance early diagnosis and improve maternal and fetal outcomes.

INTRODUCTION

Pre-eclampsia is an important obstetric complication associated with hypertension and proteinuria after 20th weeks of gestation, which threatens maternal and fetal health severely [1]. Early detection and management are essential in reducing the adverse consequences, such as maternal morbidity and mortality, fetal growth restriction (FGR) or spontaneous preterm birth [2, 3]. Precise and rapid assessment of proteinuria is crucial for diagnosis, severity classification, and risk evaluation associated with pre-eclampsia [4]. Traditionally, 24-hour urine collection has been used to quantify proteinuria in pre-eclampsia. Such an approach is, however, a 'gold standard' with many limitations, i.e. it's time-consuming, inconvenient for patients and susceptible to collection artefacts; hence, such tests, e.g. are likely to give erroneous results [1]. Instead of a 24-hour measurement, the spot urine protein-creatinine ratio (PCR) is a good alternative to evaluate proteinuria and gives an easily obtained, rapid estimation of proteinuria [2]. Several studies have shown the spot urine PCR to correlate well with 24-H urine protein excretion [5-7]. Its accuracy and reliability in comparison to 24 h collection require full validation to be able to offer clinical utility in the management of pre-eclampsia. Proteinuria is defined as >300 mg/d in the 24-h urine collection; thus, it represents one of the hallmarks of pre-eclampsia [8]. However, a simple, quick, and most commonly used screening tool to detect proteinuria is the urine dipstick test [9]. However, the sensitivity and

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specificity of the dipstick test are variable, and the test may be positive or negative in the presence of false positives or negatives for factors such as urine concentration and pH [1]. As such, more reliable diagnostic methods should be explored [10]. For pre-eclampsia pregnancies, there have been numerous studies evaluating the relationship between spot urine PCR and 24-hour urinary protein excretion in female with pre-eclamptic pregnancies [11, 12], but results are not conclusive [2]. For example, a study by Marshall et al., studied the proportion and protein content in patients having pregnancy-induced hypertension and suggested that spot urine PCR may appropriately reflect total proteinuria under specific circumstances [1]. Charles et al., analyzed renal function changes in women with pre-eclampsia in the Nigerian context, as well as stressing the need for accurate proteinuria measurement in determining disease severity. The findings also pointed out the feasibility of spot urine PCR for application in the clinical areas where timely early intervention is possible [4]. In addition, the study conducted by Walle et al., in Ethiopia, showed the value of biochemical tests for diagnosing apecolampsia by assessing proteinuria. According to them, spot urine PCR can be incorporated in the usual antenatal care to help in the early detection and management of the disease [5]. Hypertension and severe proteinuria together constitute a serious obstetric complication in the form of pre-eclampsia. Prompt diagnosis and treatment are vital to ensuring maternal and fetal safety. While the 24-hour urine collection is still considered the gold standard for quantifying proteinuria, it poses significant challenges in routine practice due to being time-consuming, inconvenient, and prone to collection errors. The spot urine protein–creatinine ratio (UPCR) offers a more practical alternative and has been widely studied internationally. However, there is limited data on its diagnostic performance in South Asian populations, particularly in low-resource, high-burden settings such as Pakistan, where factors like late antenatal presentation, variable nutritional status, and differing baseline renal profiles may influence test accuracy and utility. Furthermore, variations in laboratory practices, population demographics, and disease severity patterns necessitate local validation. In our study, significant proteinuria was defined as >300 mg/24 hours, and a UPCR cutoff of 0.3 was used for comparison.

Pre-eclampsia remains a major contributor to maternal and fetal morbidity and mortality worldwide, and accurate detection of proteinuria is essential for its diagnosis and management. Although the 24-hour urine protein test is considered the gold standard, it is time-consuming, inconvenient for patients, and prone to collection errors in routine clinical practice. The spot urine protein–creatinine ratio (UPCR) has emerged as a rapid alternative; however, its diagnostic performance may vary across different populations and clinical settings. In Pakistan, particularly in resource-limited tertiary care hospitals, local evidence validating the reliability of spot UPCR compared with 24-hour urine protein estimation remains limited, highlighting the need for population-specific evaluation. This study aims to assess the diagnostic accuracy of spot UPCR specifically in our clinical population to determine whether it can serve as a reliable and efficient substitute for 24-hour urine testing in routine antenatal care.

METHODS

This cross-sectional study was conducted in the Department of Obstetrics and Gynaecology, Tertiary Care Hospital, Bahawalpur, from November 24, 2022, to May 23, 2023. It aimed to evaluate the diagnostic accuracy of the spot urine protein–creatinine ratio (UPCR) in detecting significant proteinuria among hypertensive pregnant women diagnosed with pre-eclampsia. Ethical approval was obtained from the Institutional Review Board of Tertiary Care Hospital, Bahawalpur, before initiation of the study (Approval No. 1516/Trg/2022). Written informed consent was obtained from all participants. Participants were assured of confidentiality, voluntary participation, and the right to withdraw. In cases of suspected false positives or false negatives in UPCR or dipstick results, participants were promptly re-evaluated clinically, and additional investigations were conducted to avoid mismanagement or inappropriate clinical decisions. A total of 202 pregnant women aged 18 years or older with a diagnosis of pre-eclampsia were enrolled. Exclusion criteria included women with chronic kidney disease, active urinary tract infection, or those who refused consent. Pre-eclampsia was diagnosed according to the criteria of the American College of Obstetricians and Gynaecologists (ACOG, 2020). Eligible participants had a new-onset systolic blood pressure ≥140 mmHg or diastolic ≥90 mmHg on two separate readings at least four hours apart after 20 weeks of gestation, along with proteinuria defined as ≥300 mg/24-hour urine protein, or a spot UPCR ≥0.3, or a dipstick reading of ≥1+ on two occasions. The sample size was calculated using the formula for estimating a proportion in diagnostic test accuracy studies: $n = (Z^2 \times P \times (1 - P)) / d^2$, where: n = required sample size, Z = Z-score for desired confidence level (1.645 for 90% confidence), P = expected sensitivity or specificity (taken as 88.1% or 98.1% from previous studies) and d = margin of error (set at 10%, or 0.10). The larger value derived from calculations based on sensitivity and specificity was selected as the final sample size. This formula was applied both manually and using Open Epi (Diagnostic Test Evaluation Sample Size Calculator, available at: https://www.openepi.com/SampleSize/SSPropor.htm),

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an open-source statistical software recommended for epidemiological studies. Based on these calculations, a minimum sample size of 202 participants was determined to be statistically adequate for the study [13, 14]. Midstream clean-catch urine samples were collected using standard aseptic techniques. To minimize variability, all samples were obtained in the morning after confirming that participants had maintained adequate hydration and had not consumed excessive fluids. Spot UPCR was calculated using automated biochemical analyzers by measuring urine protein (mg/dL) and creatinine (mg/dL), and expressing the ratio in mg/g. The same samples were also tested using urine dipsticks (reagent strips) for qualitative proteinuria. A separate 24-hour urine collection was carried out for all participants following hospital protocol, and total protein excretion was measured using standard biochemical methods. Data were analyzed using SPSS version 25.0. Descriptive statistics were used to summarize demographic characteristics. Pearson's correlation was applied to assess the association between spot UPCR and 24-hour urine protein excretion. Receiver Operating Characteristic (ROC) curve analysis was conducted to evaluate the diagnostic performance of spot UPCR. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated based on a UPCR cutoff of 0.3. A p-value<0.050 was considered statistically significant.

RESULTS

This study evaluated 202 pregnant female with pre-eclampsia. On average, the participants of the study were 28.98 ± 2.37 years old and 34.48 ± 2.63 weeks' gestation. The mean proteinuria in spot urine samples calculated using the protein-creatinine ratio was 1.47 ± 1.05 mg/g, and the mean 24-H urine protein excretion was 1475.35 mg with a standard deviation of 1099.87. The variability in proteinuria levels as detected by the dipstick test among the study participants was significant. The results were distributed as follows: 17.8% negative, 18.3% trace, 22.3% 1+, 20.3% 2+, and 21.3% 3+. This variability underscores the dipstick test's utility for initial screening in clinical settings, reflecting a broad range of proteinuria among the participants (Table 1).

Table 1: Distribution of Urine Dipstick Test Results Among Pregnant Women with Pre-eclampsia

Urine Dipstick Results	Frequency (%)
Negative	36 (17.8%)
Trace	37 (18.3%)
1+	45 (22.3%)
2+	41 (20.3%)
3+	43 (21.3%)
Total	202

A substantial majority (94.1%) of the study participants exhibited significant levels of proteinuria, while only a small fraction (5.9%) did not. This high prevalence highlights the critical need for effective proteinuria screening of pre-eclampsia patients and their treatment (Table 2).

Table 2: Prevalence of Significant Proteinuria

Significant Proteinuria	Frequency (%)
No	12 (5.9%)
Significant	190 (94.1%)
Total	202

Using a UPCR cutoff of 0.3 mg/g, the test showed a sensitivity of 92.6%, specificity of 100%, positive predictive value (PPV) of 100%, and negative predictive value (NPV) of 46.2%. The overall diagnostic accuracy was 93.1%, indicating excellent agreement with 24-hour urine protein excretion. The association between spot UPCR and significant proteinuria was statistically significant (χ^2 = 86.36, p<0.001), confirming the high diagnostic utility of spot UPCR in detecting proteinuria among pre-eclamptic women (Table 3).

Table 3: Diagnostic Performance of Spot UPCR ≥0.3 Against 24-Hour Urine Protein Excretion in Women with Pre-eclampsia

Variables	UPCR Positive (≥0.3)	UPCR Negative (<0.3)	Total
Significant Proteinuria (Yes)	176 (True Positives)	14 (False Negatives)	190
No Significant Proteinuria (No)	0 (False Positives)	12 (True Negatives)	12
Total	176	26	202

The Receiver Operating Characteristic (ROC) curve was used to examine the diagnostic performance of spot UPCR. The overall diagnostic accuracy of the AUC was 0.971 in differentiating patients with and without significant proteinuria. This high AUC is suggestive of its precision and hence suitability to serve as a clinical parameter (Figure 1).

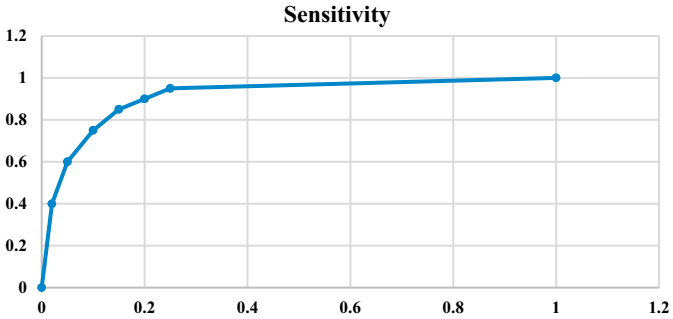

Figure 1: ROC Curve for Spot Urine Protein-Creatinine Ratio

Diagnostic Calculations: Sensitivity = TP / (TP + FN) = 176 / (176 + 14) = 92.6%. Specificity = TN / (TN + FP) = 12 / (12 + 0) = 100%. PPV (Positive Predictive Value) = TP / (TP + FP) = 176 / (176 + 0) = 100%. NPV (Negative Predictive Value) = TN / (TN + FN) = 12 / (12 + 14) = 12 / 26 = 46.2%. Diagnostic Accuracy = (TP + TN) / Total = (176 + 12) / 202 = 188 / 202 ≈ 93.1%. Chi-Square p-value = <0.001 (significant).

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DISCUSSION

The present study validates the use of spot urine protein–creatinine ratio (UPCR) as an effective diagnostic tool for identifying significant proteinuria in women with pre-eclampsia. When compared to the gold standard 24-hour urine protein measurement, spot UPCR demonstrated excellent diagnostic performance, with an area under the ROC curve (AUC) of 0.971, indicating a high level of precision in differentiating between women with and without clinically significant proteinuria. The sensitivity and specificity of spot UPCR were found to be 92.6% and 100%, respectively, reflecting its strong ability to accurately identify true positive cases without yielding any false positives. The positive predictive value (PPV) was also 100%, confirming that all positive results obtained through spot UPCR represented true cases of significant proteinuria. However, the negative predictive value (NPV) was lower at 46.2%, suggesting a limited ability of the test to confidently rule out disease in women who test negative. These findings are consistent with Olayinka *et al.,* who reported lower sensitivity and specificity values of 74% and 69%, respectively [15], and support the observations of Shaikh *et al.,* who noted improved sensitivity in cases with more severe proteinuria [16]. Given the relatively low NPV, reliance on a single negative spot UPCR result may risk underdiagnosing some cases. To mitigate this, combining UPCR testing with additional clinical indicators, such as escalating blood pressure, signs and symptoms of end-organ involvement (e.g., headache, epigastric pain, visual disturbances), and laboratory markers like elevated liver enzymes may improve diagnostic confidence. Serial measurements of UPCR may also be valuable, particularly in borderline or evolving clinical presentations. Moreover, establishing gestational age-specific cutoffs or developing predictive algorithms may further enhance the test's diagnostic utility in diverse populations. The current findings align with global literature, reinforcing the role of spot UPCR in various settings. Tian *et al.,* reported slightly lower pooled diagnostic accuracy when compared to 12-hour collections, highlighting the influence of test timing and individual variability [17]. Pallavee also emphasized that although dipstick testing offers a convenient, rapid screening option, it lacks the diagnostic accuracy provided by UPCR, especially in resource-limited settings [18]. Other studies by Stefańska *et al.,* and Shahbazian and Hosseini further support the use of spot UPCR while cautioning that factors like hydration status and renal function may affect protein excretion patterns [19, 20]. Similar conclusions were drawn by Park *et al.,* [7], Mdunge and Baloyi and Shagufta *et al.,* who endorsed the clinical reliability of UPCR as a practical and cost-effective alternative to 24-hour urine collection for the diagnosis and monitoring of pre-eclampsia [21, 22]. In conclusion, this study contributes important local data supporting the integration of spot UPCR into routine antenatal screening for pre-eclampsia. Its high diagnostic accuracy, ease of administration, and time efficiency make it a practical alternative to the cumbersome 24-hour urine collection, particularly in high-burden, resource-limited clinical settings where rapid diagnosis is essential to guide timely management.

This study has certain limitations, including its single-center design and cross-sectional methodology, which may limit the generalizability of the findings to other populations. Additionally, the study did not evaluate longitudinal maternal or fetal outcomes associated with varying levels of proteinuria. Factors such as hydration status, renal function variations, and disease severity may also influence UPCR values and were not extensively analyzed. Future multicenter studies with larger sample sizes, longitudinal follow-up, and comprehensive clinical correlations are recommended to further validate the diagnostic and prognostic utility of spot UPCR in pre-eclampsia management.

CONCLUSIONS

It was concluded that the spot UPCR is an effective and reliable tool for detecting significant proteinuria in women with pre-eclampsia. It shows a strong correlation with the gold standard 24-hour urine protein measurement. With a sensitivity of 92.6% and specificity of 100%, spot UPCR offers a practical and time-efficient alternative to 24-hour urine collection. These findings support its incorporation into routine antenatal care to enable earlier identification and better management of pre-eclampsia, thereby enhancing maternal and fetal outcomes.

Authors' Contribution

Conceptualization: NS
Methodology: NS
Formal analysis: SU
Writing and Drafting: SZ, NH, AS
Review and Editing: SZ, NH, AS, SU, NS

All authors approved the final manuscript and take responsibility for the integrity of the work

Conflicts of Interest

All the authors declare no conflict of interest.

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