ORIGINAL ARTICLE

DETERMINATION OF THE DIAGNOSTIC ACCURACY OF ALBUMIN TO CREATININE RATIO IN THE DIAGNOSIS OF DIABETIC NEPHROPATHY, TAKING MICROALBUMINURIA AS THE GOLD STANDARD

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ABSTRACT

Introduction: Diabetic nephropathy is a leading complication of type 2 diabetes mellitus (T2DM) and is primarily detected through microalbuminuria assessment. The urine albumin-to-creatinine ratio (ACR) has been proposed as a convenient alternative to 24-hour urine albumin estimation. This study evaluates the diagnostic accuracy of ACR in detecting diabetic nephropathy, using microalbuminuria as the gold standard.

Objective: To determine the sensitivity, specificity, and predictive values of the urine ACR in diagnosing diabetic nephropathy in patients with T2DM.

Methods: A cross-sectional study was conducted at the Pathology Department of CMH Institute of Medical Sciences, Bahawalpur, from February 2023 to August 2023. A total of 117 patients with T2DM aged 30-60 years were enrolled through non-probability consecutive sampling. Patients with renal failure, chronic liver disease, cardiac disease, or protein-losing enteropathies were excluded. Urine samples were analyzed for ACR and 24-hour microalbuminuria. Diagnostic performance was assessed using sensitivity, specificity, and predictive values.

Results: The mean patient age was 47.53 ± 8.64 years, with 69 males (58.97%) and 48 females (41.03%). The ACR test yielded a sensitivity of 92.31%, specificity of 80.77%, positive predictive value of 85.71%, negative predictive value of 89.36%, and overall diagnostic accuracy of 87.18%.

Conclusion: The ACR is a reliable and convenient screening tool for diabetic nephropathy, demonstrating high sensitivity and specificity. It offers a practical alternative to 24-hour urine collection for early detection and routine monitoring in clinical practice.

Keywords: *Diabetic nephropathy, type 2 diabetes mellitus, albumin-to-creatinine ratio, microalbuminuria, renal function assessment.*

INTRODUCTION:

Type 2 diabetes mellitus (T2DM) is characterized by chronic hyperglycemia due to insulin resistance and relative insulin deficiency. In contrast, type 1 diabetes mellitus (T1DM) results from absolute insulin deficiency due to autoimmune destruction of pancreatic islet cells. T2DM accounts for approximately 90% of all diabetes cases, with the remaining 10% attributed to T1DM and gestational diabetes.1

Diabetes induces widespread metabolic changes, leading to complications driven by excessive reactive oxygen species, which cause structural and functional damage to the glomeruli of the kidneys.2,3 As diabetic nephropathy progresses, the glomerular filtration barrier (GFB) becomes

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increasingly compromised, resulting in the abnormal excretion of albumin in urine. This pathological process is marked by the accumulation of proteins in Bowman's space, forming characteristic Kimmelstiel–Wilson nodules.4

Diabetic nephropathy, a leading cause of end-stage renal disease, is characterized by glomerular capillary angiopathy, progressive glomerulosclerosis, and nephrotic syndrome.5 Prolonged diabetes mellitus significantly increases the risk of renal failure, often necessitating dialysis.6 Early detection of nephropathy is crucial for improving patient outcomes. The current gold standard for diagnosing microalbuminuria—24-hour urine collection—is labor-intensive, time-consuming, and prone to collection errors.7 Alternative methods, such as the urine albumin-to-creatinine ratio (ACR), have been explored for their diagnostic utility.8

While studies have demonstrated the sensitivity and specificity of ACR in detecting diabetic nephropathy, its diagnostic accuracy remains inconsistent across different populations.9, 10 We need to validate ACR as a reliable alternative to 24-hour urine collection in our clinical setting. This study aims to evaluate the diagnostic accuracy of ACR in detecting diabetic nephropathy, using microalbuminuria as the gold standard, to facilitate early diagnosis and improve clinical decision-making.

METHODS:

Study Design: A cross-sectional, descriptive study.

Study Setting: Conducted at the Pathology Department, CMH Institute of Medical Sciences, Bahawalpur.

Study Duration: February 2023 to August 2023.

Sample Size: A total of 117 patients were included, determined using a 95% confidence level, 9.5% desired precision for a sensitivity of 86.0%, and 12% for a specificity of 60.0% in diagnosing diabetic nephropathy using the albumin-to-creatinine ratio (ACR). The expected prevalence of diabetic nephropathy was considered to be 44.0%.

Sampling Technique: Non-probability, consecutive sampling.

Inclusion Criteria:

- Patients diagnosed with type II diabetes mellitus (as per operational definition).
- Disease duration of more than six months.
- Age range between 30 and 60 years.

Exclusion Criteria:

- Patients with type I diabetes mellitus.
- Individuals with a history or clinical evidence of chronic liver disease, cardiac disease, renal failure, or hypertension.

Data Collection: Approval was obtained from the local ethical review committee before patient recruitment. A total of 117 patients fulfilling the inclusion criteria were enrolled. After obtaining informed consent, 24-hour urine samples were collected to assess the albumin-to-creatinine ratio (ACR) and microalbuminuria. ACR values were analyzed for the presence or absence of diabetic nephropathy, using microalbuminuria as the gold standard.

Data Analysis: Data were analyzed using SPSS version 26.0. Continuous variables such as age and duration of diabetes mellitus were expressed as mean ± standard deviation (SD). Categorical variables, including gender, family history of diabetes mellitus (yes/no), and diabetic nephropathy status (yes/no), were presented as frequencies and percentages. A 2×2 contingency table was used to calculate the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy of ACR in diagnosing diabetic nephropathy. Stratification was performed to control for confounding variables such as age, disease duration, and family history of diabetes mellitus. The chi-square test was applied to assess the statistical significance of these factors, with a p-value of ≤ 0.05

considered statistically significant.

RESULT:

A total of 117 patients diagnosed with type 2 diabetes mellitus (T2DM) were included in the study. The mean age of the participants was 47.53 ± 8.64 years (range: 30-60 years). The majority of the patients (n=50, 42.74%) were in the 51–60-year age group. The study cohort comprised 69 males (58.97%) and 48 females (41.03%), yielding a male-to-female ratio of 1.4:1 (Figure 1).

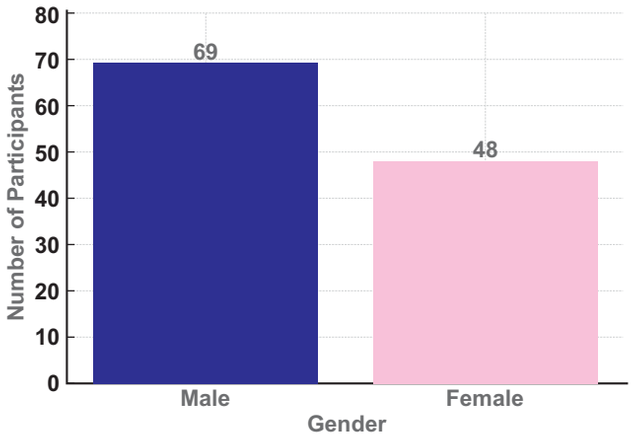

Figure 1: Gender Distribution of the Study Participants

The mean disease duration was 18.23 ± 7.32 months. Based on the urine albumin-to-creatinine ratio (ACR), diabetic nephropathy was identified in 70 (59.83%) patients. The diagnosis of diabetic nephropathy was confirmed using microalbuminuria in 65 (55.56%) cases.

Among the 70 patients who tested positive for diabetic nephropathy using ACR, 60 cases were true positive (TP) and 10 were false positive (FP). Among the 47 patients who tested negative for diabetic nephropathy, 42 were true negative (TN), while 5 were false negative (FN). The p-value for the diagnostic performance was 0.508, indicating no significant statistical difference between ACR and microalbuminuria.

The diagnostic performance of ACR in detecting diabetic nephropathy was as follows:

- Sensitivity: 92.31%
- Specificity: 80.77%
- Positive Predictive Value (PPV): 85.71%
- Negative Predictive Value (NPV): 89.36%
- Overall Diagnostic Accuracy: 87.18%

Table 1: Diagnostic Performance of Urine Albumin-to-Creatinine Ratio Compared to Microalbuminuria

Microalbuminuria (Gold Standard)	ACR Positive (n=70)	ACR Negative (n=47)	Total (N=117)
Positive (TP)	60	5	65
Negative (FP)	10	42	52
Total	**70**	**47**	**117**

*p-value = 0.508

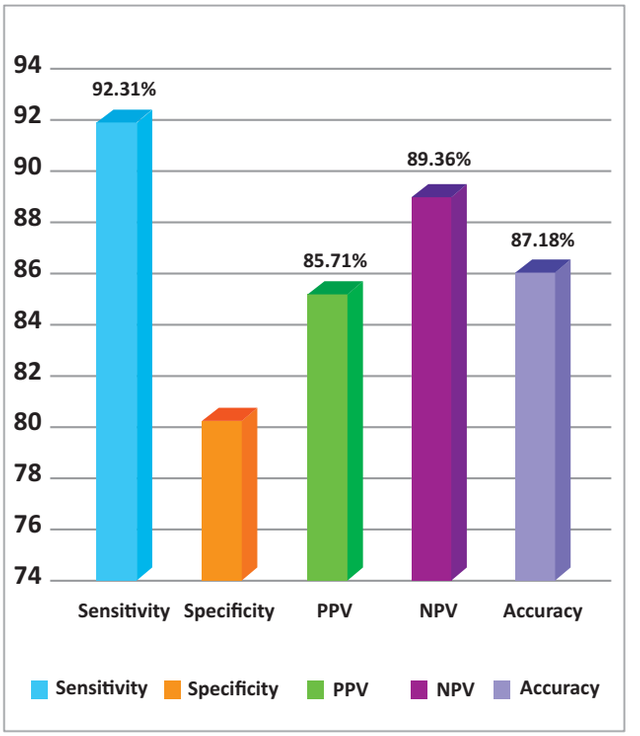

Figure 2: Sensitivity, Specificity, PPV, NPV, and Diagnostic Accuracy of ACR in Detecting Diabetic Nephropathy

The urine albumin-to-creatinine ratio (ACR) demonstrated high sensitivity (92.31%) and specificity (80.77%), making it a reliable tool for detecting diabetic nephropathy. Given its ease of use and strong correlation with microalbuminuria, ACR can serve as an effective alternative to 24-hour urine collection for diagnosing diabetic nephropathy in clinical practice.

DISCUSSION:

This study evaluated the diagnostic accuracy of the urine albumin-to-creatinine ratio (ACR) in detecting diabetic nephropathy, using microalbuminuria as the gold standard. The results demonstrated that ACR had a sensitivity of 92.31%, specificity of 80.77%, positive predictive value (PPV) of 85.71%, negative predictive value (NPV) of 89.36%, and an overall diagnostic accuracy of 87.18%. These findings indicate that ACR is a highly sensitive and specific test, making it a valuable alternative to 24-hour urine albumin estimation for diagnosing diabetic nephropathy.

Several studies have investigated the reliability of ACR as a screening tool for diabetic nephropathy. A study by Zhong et al. reported a sensitivity of 86% and specificity of 60%,11 which is lower than the sensitivity observed in our study but aligns with the specificity findings. Similarly, Geneen et al. conducted a systematic review and found that ACR had a pooled sensitivity of 87% and specificity of 88%,12 closely resembling the diagnostic performance in our study. In contrast, a study by Kaminska et al. reported 100% sensitivity and 91.3% specificity for ACR in diagnosing microalbuminuria.13 Their study demonstrated slightly better diagnostic accuracy compared to our findings, which may be attributed to differences in population characteristics, sample size, and laboratory methods used for ACR measurement.

Furthermore, Yu et al. assessed the performance of protein-to-creatinine (P:C) ratio and ACR, concluding that ACR was more reliable for early detection of diabetic nephropathy with 96.6% sensitivity and 74.4% specificity.14 Our results align with this study, confirming ACR as an effective screening tool for diabetic nephropathy.

Despite strong correlations between ACR and microalbuminuria, some studies have raised concerns regarding variability in urine concentration and hydration status, which may affect ACR measurements. Résimont et al. suggested that multiple spot urine samples over time may improve ACR reliability.15

Strengths and Limitations: This study's strengths include its well-defined diabetic population and the use of microalbuminuria as the gold standard, ensuring reliable assessment of the urine albumin-to-creatinine ratio (ACR). The findings demonstrate high sensitivity, highlighting ACR as a simple, non-invasive, and cost-effective alternative to 24-hour urine collection for detecting diabetic nephropathy. However, as a single-center study, the results may not be fully generalizable. Additionally, hydration status and urine concentration variability were not controlled, which could affect ACR measurements. The cross-sectional design limits long-term assessment of disease progression. Future multi-center, longitudinal studies are needed to further validate these findings.

CONCLUSION:

This study concludes that urine albumin-to-creatinine ratio (ACR) is a highly sensitive and specific test for diagnosing diabetic nephropathy. Given its convenience, non-invasiveness, and strong diagnostic performance, ACR can serve as an effective alternative to 24-hour urine collection for the early detection and routine monitoring of diabetic nephropathy. Further multi-center studies with larger sample sizes and longitudinal follow-up are recommended to confirm these findings and explore ACR's predictive value for disease progression.

DECLARATION OF INTEREST: The authors declare no conflict of interest.

AUTHORS CONTRIBUTIONS:

R.S.: Conceptualization, data analysis, proofreading, and final editing of the manuscript.

K.N.: Data collection, Literature review, references, and write-up

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