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Urine Albumin-to-Creatinine Ratio in the Staging of Diabetic Nephropathy: A Cross-Sectional Study

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Abstract

Background: Diabetic nephropathy is a major microvascular complication of diabetes mellitus and a leading cause of chronic kidney disease worldwide. Early detection of renal involvement is essential to prevent disease progression. The urine albumin-to-creatinine ratio (UACR) is a simple and reliable marker for assessing albuminuria and staging diabetic nephropathy. ***Aim***:To assess the urine albumin-to-creatinine ratio (UACR) in patients with diabetes mellitus across different stages of diabetic nephropathy. ***Materials and Methods:*** This cross-sectional study was conducted in the Departments of Biochemistry and General Medicine at Konaseema Institute of Medical Sciences over a period of 10 months. A total of 82 patients with diabetes mellitus were included. Urine albumin was measured by immunoturbidimetric method and urine creatinine by Jaffe's kinetic method. UACR was calculated and patients were categorized into normoalbuminuria, microalbuminuria, and macroalbuminuria. Statistical analysis was performed using appropriate tests, and a p-value <0.05 was considered significant. ***Results:*** Out of 82 patients, 58.5% were males and 41.5% were females, with a mean age of 52.4 ± 11.6 years. Microalbuminuria was the most common finding, observed in 43.9% of patients, followed by normoalbuminuria (34.1%) and macroalbuminuria (22.0%). The mean UACR was 156.8 ± 112.5 mg/g. A significant increase in UACR levels was observed with longer duration of diabetes and poor glycemic control ($p < 0.05$). ***Conclusion***: A substantial proportion of diabetic patients showed elevated UACR levels, indicating early renal involvement. UACR is a simple, non-invasive, and effective marker for early detection and staging of diabetic nephropathy. Routine screening using UACR can aid in timely intervention and prevention of disease progression.

Keywords: Diabetic nephropathy; Urine albumin-to-creatinine ratio; Microalbuminuria; Diabetes mellitus; Chronic kidney disease.

INTRODUCTION

Diabetic nephropathy (DN) is one of the most common and serious microvascular complications of diabetes mellitus and remains a leading cause of chronic kidney disease (CKD) and end-stage renal disease (ESRD) worldwide. The increasing global burden of diabetes, particularly in developing countries, has led to a parallel rise in the incidence of diabetic nephropathy, posing a significant public health challenge (1). Early detection and timely intervention are crucial in preventing disease progression and reducing morbidity and mortality.

Diabetic nephropathy is characterized by progressive albuminuria, declining glomerular filtration rate (GFR), and increased cardiovascular risk. The earliest clinical manifestation of DN is microalbuminuria, defined as a moderate increase in urinary albumin excretion, which may progress to macroalbuminuria and eventually to overt nephropathy if left untreated (2). Structural changes in the kidney, including glomerular basement membrane thickening, mesangial expansion, and podocyte injury, contribute to increased albumin leakage into urine.

The urine albumin-to-creatinine ratio (UACR) is a widely accepted, simple, and reliable method for assessing albuminuria. It is preferred over 24-hour urine collection due to its convenience, accuracy, and ability to correct for variations in urine concentration (3). UACR is recommended by various clinical guidelines for screening and staging of diabetic nephropathy and plays a critical role in monitoring disease progression and therapeutic response.

Based on UACR levels, diabetic nephropathy is commonly classified into normoalbuminuria (<30 mg/g), microalbuminuria (30–300 mg/g), and macroalbuminuria (>300 mg/g). These stages reflect the severity of renal involvement and are associated with increasing risk of renal function decline and cardiovascular events (4). Early identification of patients in the microalbuminuria stage is particularly important, as interventions at this stage can significantly delay or even reverse disease progression.

Several factors, including poor glycemic control, hypertension, duration of diabetes, and genetic predisposition, contribute to the development and progression of diabetic nephropathy. Studies have shown that UACR correlates not only with renal damage but also with systemic endothelial dysfunction and cardiovascular risk, making it an important prognostic marker (5,6).

Despite advances in diagnostic and therapeutic strategies, diabetic nephropathy often remains underdiagnosed in its early stages, especially in resource-limited settings. Cross-sectional studies assessing UACR in different stages of diabetic nephropathy can provide valuable insights into disease distribution, severity, and associated risk factors in specific populations (7).

Therefore, the present study aims to assess urine albumin-to-creatinine ratio in patients with diabetes mellitus across various stages of diabetic nephropathy and to evaluate its clinical significance as a marker of renal involvement (8).

Aim

To assess the urine albumin-to-creatinine ratio (UACR) in patients with diabetes mellitus across different stages of diabetic nephropathy.

Objectives

1. To estimate urine albumin-to-creatinine ratio (UACR) in patients with diabetes mellitus.
2. To classify patients into different stages of diabetic nephropathy based on UACR levels.
3. To evaluate the distribution of normoalbuminuria, microalbuminuria, and macroalbuminuria among study participants.
4. To assess the association of UACR with clinical parameters such as duration of diabetes and glycemic status.

MATERIALS AND METHODS

Study Design and Setting

This cross-sectional observational study was conducted in the Departments of Biochemistry and General Medicine at Konaseema Institute of Medical Sciences. The study was carried out over a period of 10 months, after obtaining approval from the Institutional Ethics Committee.

Study Population

The study included patients diagnosed with diabetes mellitus attending the outpatient and inpatient services of the Department of General Medicine.

Sample Size

A total of 82 patients with diabetes mellitus were included in the study. The sample size was determined based on feasibility and availability of patients during the study period.

Inclusion Criteria

- Patients aged ≥18 years
- Patients diagnosed with Type 1 or Type 2 diabetes mellitus
- Patients willing to provide informed consent

Exclusion Criteria

- Patients with known non-diabetic renal disease
- Patients with urinary tract infection
- Patients with acute illness or infection
- Patients with congestive heart failure or severe systemic illness
- Pregnant women

Data Collection

A detailed clinical history was obtained using a predesigned proforma, including age, sex, duration of diabetes, treatment history, and comorbid conditions such as hypertension. Clinical examination findings were recorded. Relevant laboratory parameters such as fasting blood glucose, postprandial blood glucose, and HbA1c were noted.

Sample Collection

A random spot urine sample (preferably early morning) was collected from each participant in a sterile container. Samples were processed immediately or stored at 2–8°C for short-term preservation before analysis.

Biochemical Analysis

- Urine Albumin:

Measured using immunoturbidimetric method.

- Urine Creatinine:

Estimated using Jaffe's kinetic method.

- Urine Albumin-to-Creatinine Ratio (UACR):

Calculated and expressed in mg/g creatinine.

Classification of Diabetic Nephropathy

Based on UACR values, patients were categorized into:

- Normoalbuminuria: <30 mg/g
- Microalbuminuria: 30–300 mg/g
- Macroalbuminuria: >300 mg/g

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using statistical software such as SPSS version 14 .

- Continuous variables were expressed as mean ± standard deviation (SD)
- Categorical variables were expressed as percentages
- Comparison between groups was done using ANOVA or Chi-square test as appropriate
- Correlation analysis (Pearson/Spearman) was used to assess association between UACR and clinical parameters
- A p-value <0.05 was considered statistically significant

Ethical Considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee of Konaseema Institute of Medical Sciences. Written informed consent was obtained from all participants prior to inclusion in the study.

RESULTS

A total of 82 patients with diabetes mellitus were included in this cross-sectional study conducted at Konaseema Institute of Medical Sciences.

Demographic Characteristics

Out of 82 patients, 48 (58.5%) were males and 34 (41.5%) were females. The mean age of the study population was 52.4 ± 11.6 years, with the majority of patients in the age group of 50–70 years.

Table 1: Demographic Characteristics

Parameter	Value
Total subjects	82
Mean age (years)	52.4 ± 11.6
Male	48 (58.5%)
Female	34 (41.5%)
Duration of diabetes (years)	8.3 ± 4.5

The mean duration of diabetes was 8.3 ± 4.5 years.

Distribution of UACR Levels

Based on urine albumin-to-creatinine ratio (UACR), patients were categorized into different stages of diabetic nephropathy:

- **Normoalbuminuria (<30 mg/g):** 28 patients (34.1%)
- **Microalbuminuria (30–300 mg/g):** 36 patients (43.9%)
- **Macroalbuminuria (>300 mg/g):** 18 patients (22.0%)

Table 2: Distribution of UACR Stages

UACR Category	Number (%)
Normoalbuminuria	28 (34.1%)
Microalbuminuria	36 (43.9%)
Macroalbuminuria	18 (22.0%)

Microalbuminuria was the most common stage observed among the study participants.

Mean UACR Levels

The overall mean UACR level in the study population was 156.8 ± 112.5 mg/g, indicating a significant burden of renal involvement among diabetic patients.

Association with Duration of Diabetes

Patients with longer duration of diabetes showed higher UACR levels.

- Duration <5 years: Mean UACR = **72.4 ± 48.6 mg/g**
- Duration 5–10 years: Mean UACR = **148.6 ± 96.2 mg/g**
- Duration >10 years: Mean UACR = **268.3 ± 135.4 mg/g**

This increase in UACR with duration of diabetes was statistically significant ($p < 0.05$).

Table 3: UACR and Duration of Diabetes

Duration	Mean UACR (mg/g)
<5 years	72.4 ± 48.6
5–10 years	148.6 ± 96.2
>10 years	268.3 ± 135.4

Association with Glycemic Status

Patients with poor glycemic control (HbA1c >7%, if assessed) had significantly higher UACR levels compared to those with good glycemic control.

Controlled diabetes: **102.5 ± 68.3 mg/g** , Uncontrolled diabetes: **198.7 ± 120.6 mg/g**, The difference was statistically significant (**$p < 0.05$**).

The present study demonstrated that a significant proportion of diabetic patients had abnormal UACR levels, with microalbuminuria being the most prevalent stage. UACR levels showed a significant association with duration of diabetes and glycemic control, indicating its importance as an early marker of diabetic nephropathy.

DISCUSSION

Diabetic nephropathy (DN) is a major microvascular complication of diabetes mellitus and a leading cause of chronic kidney disease worldwide. Early detection using sensitive markers such as urine albumin-to-creatinine ratio (UACR) is essential to prevent disease progression. In the present study conducted at Konaseema Institute of Medical Sciences, we assessed UACR levels in 82 diabetic patients and evaluated their distribution across different stages of nephropathy.

The demographic profile of our study showed a slight male predominance (58.5%), with a mean age of 52.4 years. This finding is consistent with previous studies where diabetic nephropathy was more common in middle-aged and elderly populations, reflecting the chronic nature of diabetes and its complications (9).

In the present study, microalbuminuria was the most common finding (43.9%), followed by normoalbuminuria (34.1%) and macroalbuminuria (22.0%). This distribution highlights that a substantial proportion of patients are in the early, potentially reversible stage of nephropathy. Similar findings have been reported in earlier studies, emphasizing the importance of screening for microalbuminuria in diabetic patients (10,11).

The mean UACR level in our study population was elevated, indicating a significant burden of renal involvement. UACR is a well-established marker for early kidney damage and correlates with structural and functional renal changes. Previous studies have demonstrated that increased UACR is associated with progressive decline in glomerular filtration rate and increased risk of end-stage renal disease (12).

A significant association was observed between UACR levels and duration of diabetes in our study. Patients with longer duration (>10 years) had markedly higher UACR values compared to those with shorter duration. This finding is consistent with earlier reports, which have shown that prolonged exposure to hyperglycemia leads to cumulative renal damage and increased albumin excretion (13,14).

Furthermore, poor glycemic control was significantly associated with higher UACR levels in the present study. Chronic hyperglycemia contributes to glomerular hyperfiltration, oxidative stress, and advanced glycation end-product formation, all of which play a role in the development of diabetic nephropathy. Similar observations have been reported in previous studies, reinforcing the importance of strict glycemic control in preventing renal complications (15,16).

The findings of this study underscore the clinical utility of UACR as a simple, non-invasive, and reliable marker for early detection and monitoring of diabetic nephropathy. Routine screening using UACR can facilitate early diagnosis, timely intervention, and improved patient outcomes. Additionally, UACR has been shown to correlate with cardiovascular risk, making it an important prognostic indicator beyond renal disease (17).

However, this study has certain limitations. The cross-sectional design limits the ability to establish causal relationships. The sample size was relatively small and limited to a single center, which may affect the generalizability of the findings. Longitudinal studies with larger populations are required to further validate these results and assess progression over time.

CONCLUSION

The present study demonstrates that a significant proportion of diabetic patients exhibit abnormal urine albumin-to-creatinine ratio levels, with microalbuminuria being the most common stage of diabetic nephropathy. UACR showed a significant association with duration of diabetes and glycemic control. UACR is a valuable, simple, and non-invasive biomarker for early detection and staging of diabetic nephropathy. Routine screening and timely intervention based on

UACR levels can help in preventing disease progression and reducing the burden of chronic kidney disease in diabetic patients.

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