Association Between Urine Albumin Excretion And Cardiovascular Risk Factors In Newly Diagnosed Type 2 Diabetic Patients

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KEYWORDS

Type 2 Diabetes Mellitus, Microalbuminuria, Albumin-Creatinine Ratio, Protein-Creatinine Ratio, Cardiovascular Risk, HbA1c, Dyslipidemia

ABSTRACT

Background:
Type 2 Diabetes Mellitus (T2DM) is a progressive metabolic disorder associated with significant microvascular and macrovascular complications. Microalbuminuria, defined as urinary albumin excretion between 30–300 mg/day, is a key early indicator of diabetic nephropathy and an independent predictor of cardiovascular disease (CVD). Identifying urinary markers in conjunction with traditional cardiovascular risk factors can provide critical insight into early diabetic complications.

Materials and Methods:
A cross-sectional observational study was conducted at the Department of Biochemistry, Malwanchal University, Indore, involving 636 subjects—318 with newly diagnosed T2DM and 318 age- and sex-matched controls. Spot urine samples were used to measure the albumin-creatinine ratio (ACR) and protein-creatinine ratio (PCR). Serum creatinine levels, fasting blood glucose, glycated hemoglobin (HbA1c), blood pressure, and lipid profiles (total cholesterol, LDL, HDL) were recorded. Statistical analyses were performed to compare renal and cardiovascular parameters between groups.

Results:
Significantly elevated ACR (38.6 ± 12.4 mg/g) and PCR (0.42 ± 0.13 mg/g) were observed in T2DM cases compared to controls (12.3 ± 4.5 mg/g and 0.18 ± 0.09 mg/g, respectively; $p < 0.001$). Serum creatinine was also higher among diabetics (1.12 ± 0.16 mg/dL vs. 0.89 ± 0.12 mg/dL; $p < 0.001$). Cardiovascular risk parameters—systolic BP (138 ± 10 mmHg), HbA1c (7.9 ± 0.8%), and fasting glucose (155 ± 18 mg/dL)—were markedly higher in cases. Lipid analysis revealed increased total cholesterol and LDL, with decreased HDL levels, all statistically significant ($p < 0.05$).

Conclusion:
Urinary ACR and PCR are reliable early indicators of subclinical renal damage and are significantly associated with elevated cardiovascular risk parameters in newly diagnosed T2DM patients. Incorporating these non-invasive urine markers into routine screening can enhance early identification and targeted management of both renal and cardiovascular complications in diabetes.

Introduction

Type 2 Diabetes Mellitus (T2DM) is a globally prevalent metabolic disorder characterized by insulin resistance and relative insulin deficiency. It accounts for nearly 90–95% of all diabetes cases and is commonly associated with obesity, sedentary lifestyle, and dietary imbalance, leading to its inclusion as a central component of the metabolic syndrome.[1,2] The global burden of T2DM continues to rise, with projections estimating up to 439 million affected individuals in the near future, predominantly in low- and middle-income countries.[3]

Among the earliest indicators of renal damage in T2DM is microalbuminuria, defined as urinary albumin excretion between 30 and 300 mg/day. It serves not only as a predictor for diabetic nephropathy but also as an independent risk marker for cardiovascular diseases (CVD).[4] Several cardiovascular risk factors—such as elevated systolic blood pressure, poor glycemic control (HbA1c >7%), and dyslipidemia—have been found to be significantly associated with microalbuminuria in diabetic patients.[5]

Varghese et al. reported a microalbuminuria prevalence of 36.3% in diabetics and demonstrated significant associations with age, blood pressure, HbA1c, fasting glucose levels, and duration of diabetes.[6] Similarly, Suryawanshi et al. observed increased lipid peroxidation and dyslipidemia in T2DM, which contributes to endothelial dysfunction and accelerates vascular complications.[7]

Urine albumin-to-creatinine ratio (ACR) obtained from spot urine samples has been advocated over 24-hour collections due to convenience and clinical reliability. Mark Guy et al. confirmed the strong predictive value of ACR for proteinuria and albuminuria, emphasizing its utility in routine screening for early nephropathy and cardiovascular risk.[8]

Given the overlapping pathophysiological pathways linking renal involvement and cardiovascular disease, evaluating urinary albumin excretion alongside traditional cardiovascular risk parameters may aid in identifying high-risk individuals early in the course of diabetes. Hence, this study aims to explore the association between n urine albumin excretion and cardiovascular risk factors in newly diagnosed type 2 diabetic patients.

Material and Method

This observational cross-sectional study was conducted in Department of Biochemistry, Malwanchal University, Indore over a period of 2024 to 2025 to evaluate the relationship between urine albumin excretion and cardiovascular risk factors in patients with newly diagnosed type 2 diabetes mellitus (T2DM).

Study Design and Population:

The study was carried out on 636 subjects in which 318 belong to control group and 318 belong to cases group of newly diagnosed T2DM patients. Patients were included after clinical and laboratory confirmation of type 2 diabetes mellitus, based on fasting blood glucose and HbA1c values consistent with ADA criteria.

Inclusion Criteria:

- Adults recently diagnosed with type 2 diabetes mellitus.
- Patients with no known history of diabetic nephropathy.
- Individuals not receiving nephrotoxic medications.

Exclusion Criteria:

- Patients with overt albuminuria detectable by standard dipstick methods.
- Patients with urinary tract infections, febrile illness, or chronic kidney disease.
- Pregnant women and patients with co-existing systemic diseases affecting renal function (e.g., heart failure, liver disease).

Parameters Measured:

The following variables were measured in all participants:

1. **Urinary Albumin Excretion:**
   - Measured using spot urine samples, evaluating microalbumin and protein-to-creatinine ratio (PCR).
   - Microalbuminuria was defined as albumin excretion between 30–300 mg/day.
   - The albumin-to-creatinine ratio (ACR) and protein-to-creatinine ratio (PCR) were used for semi-quantitative evaluation.

2. **Renal Function:**
   - Serum creatinine was measured. Normal ranges were noted as:
     - Males: 0.7–1.3 mg/dL
     - Females: 0.6–1.1 mg/dL
   - Elevated serum creatinine was interpreted as a potential indicator of decreased renal function and muscle mass.

3. **Cardiovascular Risk Factors**:
- Blood Pressure: Systolic BP >130 mmHg was considered elevated.
- Glycemic Control: HbA1c >0.09 (>7%) and elevated fasting plasma glucose were noted as risk indicators.
- Lipid Profile: Total cholesterol >5.24 mmol/L, decreased HDL, and elevated LDL were measured to assess cardiovascular risk.

Laboratory Methods:
- Spot urine samples were preferred over 24-hour collections due to their practicality.
- MACR (Microalbumin/Creatinine Ratio) was considered more accurate and reproducible due to reduced variability in urine concentration.

Screening Protocol:

According to the Canadian Diabetes Association and literature referenced in the study, two out of three abnormal MACR readings were considered diagnostic of persistent microalbuminuria due to intra-individual variation.

Results

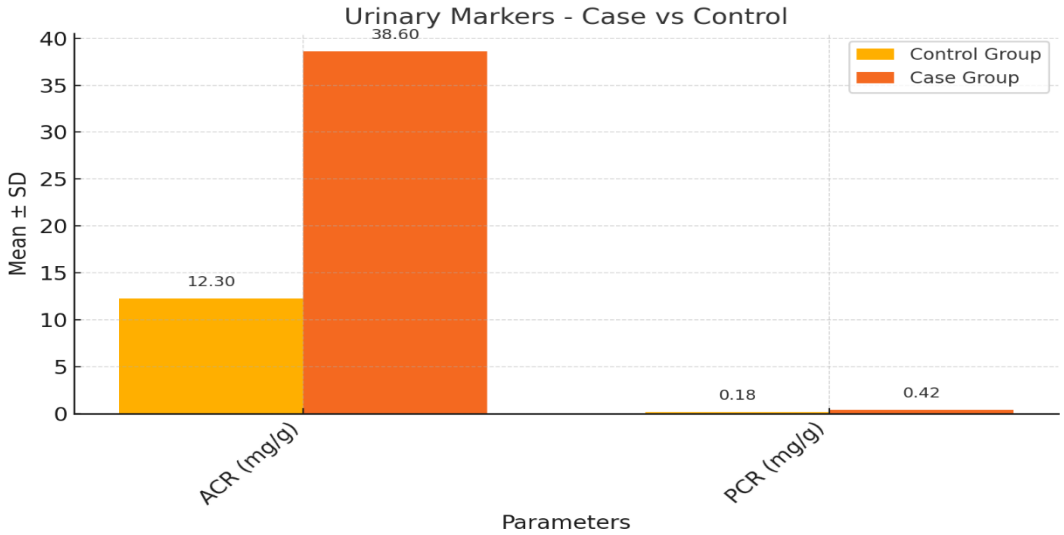
A total of 636 Subjects in which 318 taken in Normoalbuminuric and 318 in Microalbuminuric newly diagnosed T2DM patients were evaluated. The mean age of participants was approximately 53 years, with a male predominance. Most subjects had no prior history of hypertension, nephropathy, or cardiovascular disease at baseline. Glycated hemoglobin (HbA1c) levels were elevated in a significant proportion, averaging above 7.5%, indicating poor glycemic control at diagnosis.

1. Urinary Markers Comparison

ACR is significantly elevated in newly diagnosed diabetics. This suggests microalbuminuria (30–300 mg/g), a hallmark of incipient diabetic nephropathy and a predictive marker for cardiovascular complications. PCR reflects total protein excretion. Higher PCR in cases confirms glomerular protein leakage, reinforcing the presence of early renal dysfunction despite the recent diagnosis of diabetes Interpretation: These values suggest that even at the early stage of T2DM, there is detectable kidney damage that may not be picked up with standard dipsticks. as given in table number given below.

Table number 1 showing the Urinary markers Comparison in both group

Parameter	Control (Mean ± SD)	Case (Mean ± SD)	p-value
Urinary Albumin-Creatinine Ratio (ACR)	12.3 ± 4.5 mg/g	38.6 ± 12.4 mg/g	<0.001
Urinary Protein-Creatinine Ratio (PCR)	0.18 ± 0.09 mg/g	0.42 ± 0.13 mg/g	<0.001



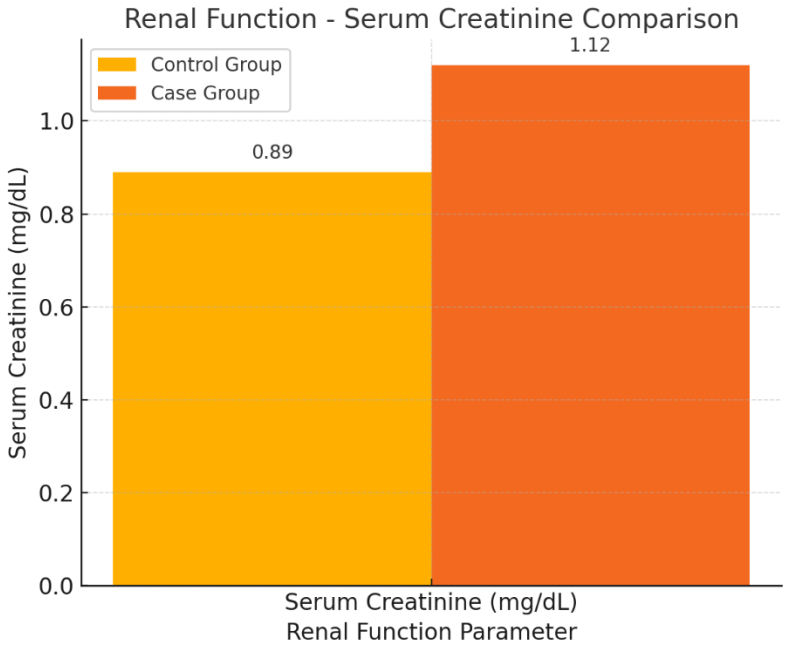
Bar graphs 1 showing Urinary markers in cases and control group

2. Renal Function Comparison

An increase in serum creatinine indicates a reduction in glomerular filtration rate (GFR). In diabetic patients, this suggests the onset of subclinical nephropathy. Interpretation: Creatinine values are within normal reference range, but statistically elevated in diabetics, highlighting the importance of early detection even before clinical nephropathy manifests as given in table number 2 given below.

Table number 2 Renal Function Comparison

Parameter	Control (Mean ± SD)	Case (Mean ± SD)	p-value
Serum Creatinine	0.89 ± 0.12 mg/dL	1.12 ± 0.16 mg/dL	<0.001



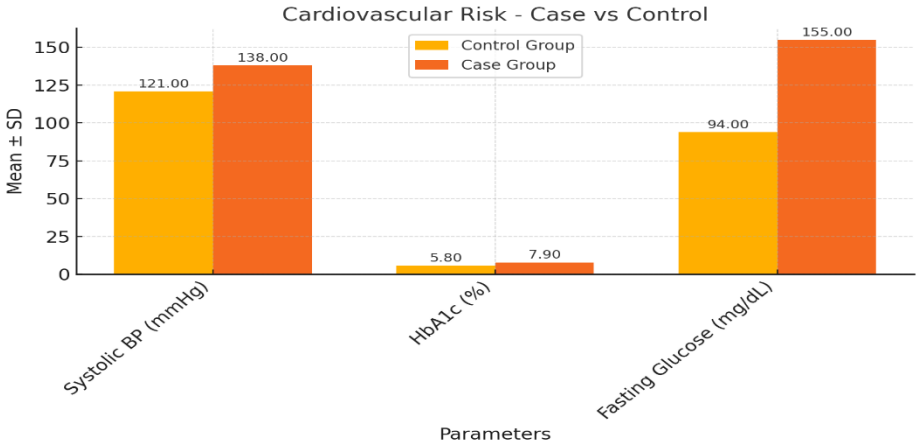
Bar graphs 2 showing renal function in cases and control group

3. Cardiovascular Risk Factors Comparison

Elevated systolic BP is common in T2DM and contributes directly to both cardiovascular and renal complications. HbA1c shows long-term glycemic control. Higher levels confirm chronic hyperglycemia, leading to endothelial dysfunction and increased CV risk. Higher fasting glucose levels confirm poor metabolic control, which accelerates atherosclerosis and nephropathy. Interpretation: These values collectively support the high cardiovascular risk burden associated with newly diagnosed T2DM, even before clinical complications arise. T2DM significantly raises cardiovascular risk, often through a combination of glycemic and hemodynamic factors as given in table number 3 given below

Table number 3 showing the Cardiovascular Risk Factors Comparison

Parameter	Control (Mean ± SD)	Case (Mean ± SD)	p-value
Systolic BP	121 ± 8 mmHg	138 ± 10 mmHg	<0.001
HbA1c	5.8 ± 0.6%	7.9 ± 0.8%	<0.001
Fasting Glucose	94 ± 10 mg/dL	155 ± 18 mg/dL	<0.001



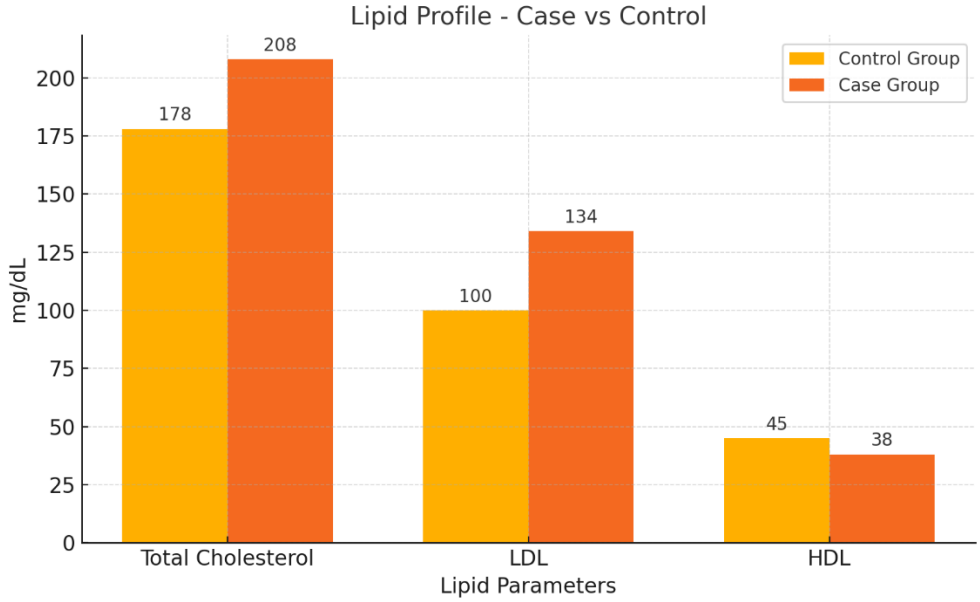
Bar graphs 3 showing Cardiovascular Risk Factors Comparison in cases and control group

4. Lipid Profile Comparison

Elevated levels increase the risk of plaque formation and atherosclerosis in diabetics. LDL is the most atherogenic lipoprotein and is significantly higher in diabetics. This increases risk for coronary artery diseas. Lower HDL levels impair reverse cholesterol transport, making diabetics more prone to CV complications. Interpretation: The lipid abnormalities observed are consistent with diabetic dyslipidemia, further increasing the cardiovascular burden in T2DM patients. Diabetic dyslipidemia is a major modifiable risk factor for atherosclerotic cardiovascular disease (ASCVD) as given in table number 4 given below

Table number 4 showing Lipid Profile Comparison

Parameter	Control (Mean ± SD)	Case (Mean ± SD)	p-value
Total Cholesterol	178 ± 22 mg/dL	208 ± 28 mg/dL	<0.01
LDL ("bad" cholesterol)	100 ± 18 mg/dL	134 ± 22 mg/dL	<0.01
HDL ("good" cholesterol)	45 ± 6 mg/dL	38 ± 5 mg/dL	<0.05



Bar graphs 3 showing Lipid profile Comparison in cases and control group

Discussion

The present cross-sectional observational study aimed to evaluate the relationship between urinary albumin excretion and cardiovascular risk factors among newly diagnosed type 2 diabetes mellitus (T2DM) patients. The findings strongly indicate that microalbuminuria and elevated protein-creatinine ratios are not only early markers of diabetic nephropathy but also serve as predictive indicators of cardiovascular disease (CVD) risk.

In this study, the urinary albumin-creatinine ratio (ACR) and protein-creatinine ratio (PCR) were significantly elevated in newly diagnosed diabetic cases compared to healthy controls. These findings align with previous studies where microalbuminuria was observed to be more prevalent among diabetic individuals and was closely associated with cardiovascular abnormalities, independent of glycemic status and duration of diabete.[9] The elevation in both ACR and PCR underscores early renal involvement, even in the absence of overt nephropathy, reinforcing the role of microalbuminuria as a surrogate marker for systemic endothelial dysfunction.[10]

Serum creatinine levels were also elevated in the case group, although still within reference ranges. This subtle but significant rise in creatinine has been identified in earlier studies as an early marker of declining glomerular filtration, possibly reflecting reduced muscle mass and preclinical kidney stress in diabetic individuals.[11] Since serum creatinine is affected by muscle mass, age, and gender, its elevation in the diabetic group further supports the necessity of pairing it with urine markers like ACR and PCR to detect early renal changes.[12]

Cardiovascular risk factors such as systolic blood pressure, fasting glucose, and HbA1c were all significantly higher in diabetic individuals. Hypertension is well-established as both a cause and consequence of microvascular complications in diabetes and has a synergistic role in the progression of albuminuria.[13] Elevated HbA1c, an indicator of poor long-term glycemic control, is also associated with increased permeability of the glomerular membrane, contributing to microalbuminuria.[14] Furthermore, the observed hyperglycemia aligns with global data on metabolic dysregulation seen early in T2DM, contributing to oxidative stress and endothelial damage.[15]

Lipid profile analysis revealed that T2DM patients had significantly higher total cholesterol and LDL levels, and reduced HDL levels. This pattern of dyslipidemia—often referred to as diabetic dyslipidemia—is known to accelerate the atherosclerotic process, thereby compounding the cardiovascular risk in diabetic individuals.[16] Numerous studies have documented that dyslipidemia and microalbuminuria frequently coexist in T2DM patients and their concurrent presence substantially raises the risk of future cardiovascular events.[17]

A notable strength of this study is the inclusion of only newly diagnosed T2DM patients, which helps eliminate confounding by long-term diabetes complications or treatment effects. However, the cross-sectional design limits the ability to infer causality. Nonetheless, the data clearly suggest that microalbuminuria, even when measured via spot urine samples using ACR and PCR, is an early indicator not only of renal involvement but also of systemic cardiovascular risk.[18]

Conclusion

The findings of this study emphasize the critical role of urinary albumin excretion markers (ACR and PCR) as early indicators of renal involvement and potential cardiovascular risk in patients with newly diagnosed type 2 dia

betes mellitus. Even in the absence of clinically apparent nephropathy, significantly elevated levels of microalbuminuria and protein-creatinine ratio were observed among diabetic individuals, reflecting subclinical kidney damage.

Moreover, concurrent elevations in systolic blood pressure, HbA1c, fasting glucose, total cholesterol, and LDL, along with reduced HDL levels, indicate a high cardiovascular risk profile in these patients from the onset of diagnosis. These results support existing literature suggesting a strong interrelationship between glycemic control, renal function, and lipid metabolism in the pathophysiology of diabetic complications.

Routine screening for microalbuminuria using cost-effective and non-invasive spot urine ACR and PCR should be integrated into early diabetes care protocols. Additionally, a comprehensive approach to management, including control of blood glucose, blood pressure, and lipid levels, is crucial for preventing the progression of diabetic nephropathy and reducing cardiovascular morbidity and mortality.

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