RESEARCH PAPER

Correlation Between Microalbuminuria and HbA1c Levels in Patients with Type 2 Diabetes Mellitus: A Cross-Sectional Study

Puneeth C M[1*], Ravi Nagarajiahah[2], Shashank B N[3]

[1]Junior Resident, Department of General Medicine, Adichunchanagiri Institute of Medical Sciences, Adichunchanagiri University, B G Nagara-571448, Karnataka, India.*
Email: drpuneethcm@gmail.com.
[2]Professor and HOD, Department of General Medicine, Adichunchanagiri Institute of Medical Sciences, Adichunchanagiri University, B G Nagara-571448, Karnataka, India.
[3]Senior Resident, Department of General Medicine, Adichunchanagiri Institute of Medical Sciences, Adichunchanagiri University, B G Nagara-571448, Karnataka, India.

ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is a major global health problem and is associated with several microvascular complications, including diabetic nephropathy. Microalbuminuria is an early indicator of renal involvement and reflects ongoing glomerular damage. Glycated hemoglobin (HbA1c) is an established marker of long-term glycemic control and plays a critical role in predicting diabetic complications.

Objective: To evaluate the association between HbA1c levels and microalbuminuria in patients with T2DM and to determine the role of HbA1c as a predictor of early diabetic nephropathy.

Methods: A hospital-based cross-sectional study was conducted among 100 patients diagnosed with T2DM at Adichunchanagiri Institute of Medical Sciences, affiliated with Adichunchanagiri University. Adult patients aged >18 years with known or newly diagnosed T2DM were included. Patients with non-diabetic causes of proteinuria, pregnancy, acute illness, or malignancy were excluded. Clinical evaluation included measurement of HbA1c, fasting blood sugar, postprandial blood sugar, lipid profile, renal function tests, and urine albumin-to-creatinine ratio (ACR). Statistical analysis was performed using Pearson correlation, chi-square test, and ANOVA.

Results: The mean age of participants was 53.1 ± 10.8 years, with a male predominance (57%). The mean HbA1c level was 7.44%. Microalbuminuria was present in 60% of participants. A strong positive correlation was observed between HbA1c and urinary albumin levels ($r = 0.914$, $p < 0.001$). Patients with HbA1c >10% showed significantly higher albuminuria compared to those with HbA1c <7.5%. Higher HbA1c levels were also associated with dyslipidemia and hypertension.

Conclusion: Poor glycemic control is strongly associated with the presence and severity of microalbuminuria in T2DM patients. Routine screening of HbA1c and microalbuminuria can facilitate early detection of diabetic nephropathy and help prevent progression to chronic kidney disease.

Keywords: Type 2 diabetes mellitus, HbA1c, microalbuminuria, diabetic nephropathy, albumin-to-creatinine ratio.

How to cite this article: Puneeth CM, Nagarajaiah R, Shashank BN. Correlation Between Microalbuminuria and HbA1c Levels in Patients with Type 2 Diabetes Mellitus: A Cross-Sectional Study. Int J Drug Deliv Technol. 2026;16(60s):392-395. DOI: 10.25258/ijddt.16.60s.45.

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The prevalence of type 2 diabetes mellitus is rapidly increasing worldwide and is associated with significant morbidity due to microvascular and macrovascular complications.[1]

Diabetic nephropathy is one of the most serious microvascular complications and is the leading cause of chronic kidney disease globally. Microalbuminuria represents the earliest clinically detectable stage of diabetic nephropathy and serves as an important predictor for progression to overt proteinuria and renal failure.[2]

Persistent hyperglycemia plays a central role in the pathogenesis of diabetic nephropathy through mechanisms such as advanced glycation end product formation, oxidative stress, and activation of protein kinase pathways.[3-6] These biochemical pathways result in structural changes including glomerular basement membrane thickening and mesangial expansion.

Glycated hemoglobin (HbA1c) reflects average plasma glucose concentration over the preceding 2-3 months and is widely used to monitor glycemic control. Poor glycemic control has been shown to accelerate the development of microvascular complications, including nephropathy.[7-9]

Guidelines from the American Diabetes Association recommend periodic screening for microalbuminuria in all patients with type 2 diabetes mellitus.[10] Similarly, the Kidney Disease: Improving Global Outcomes guidelines emphasize albuminuria as a key marker for early detection and staging of chronic kidney disease.[11]

Early identification of patients at risk allows timely intervention and prevention of disease progression. Therefore, the present study was undertaken to evaluate the association between HbA1c and microalbuminuria in patients with type 2 diabetes mellitus.

MATERIALS AND METHODS

STUDY SETTING AND DURATION

This hospital-based cross-sectional study was conducted in the Department of General Medicine at Adichunchanagiri Hospital and Research Centre over a defined study period of 18 months, from May 2024 to October 2025.

STUDY POPULATION

A total of 100 patients admitted to the General Medicine department of Adichunchanagiri Hospital and Research Centre and diagnosed with type 2 diabetes mellitus as per ADA criteria were included in the study.

INCLUSION CRITERIA

Adults aged ≥18 years, known or newly diagnosed cases of T2DM, and patients willing to provide informed consent were included.

EXCLUSION CRITERIA

Pregnancy, acute infections or acute illness, malignancy, known non-diabetic renal disease, and patients with macroalbuminuria or overt nephropathy were excluded.

DATA COLLECTION

Detailed clinical history and physical examination were performed for all participants. Investigations included fasting blood sugar (FBS), postprandial blood sugar (PPBS), glycated hemoglobin (HbA1c), renal function tests (serum urea and creatinine), lipid profile, spot urine albumin-to-creatinine ratio (ACR), and ultrasonography of the abdomen when indicated. Microalbuminuria was defined as urine ACR between 30 and 300 mg/g.

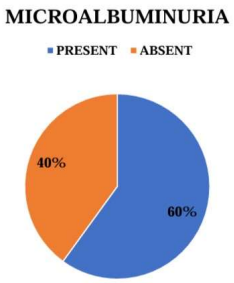

Figure 1: Prevalence of microalbuminuria

STATISTICAL ANALYSIS

Statistical analysis was performed using standard statistical software. Continuous variables were expressed as mean ± standard deviation and categorical variables as percentages. Pearson correlation coefficient was used to assess the relationship between HbA1c and microalbuminuria. Chi-square test and ANOVA were used to compare categorical and continuous variables, respectively. A p-value <0.05 was considered statistically significant.

RESULTS

DEMOGRAPHIC CHARACTERISTICS

The mean age of study participants was 53.1 years. The majority of patients belonged to the age group of 41-60 years. Males constituted 57% of the study population, while females accounted for 43%.

GLYCEMIC PROFILE

The mean HbA1c level among participants was 7.44%. Approximately 32% had HbA1c <7%, 45% had HbA1c between 7% and 9%, and 23% had HbA1c >9%. This distribution indicates a substantial proportion of patients with suboptimal glycemic control.

PREVALENCE OF MICROALBUMINURIA

Microalbuminuria was detected in 60% of patients, while 40% had normal urine albumin levels. The prevalence increased with longer duration of diabetes, higher HbA1c levels, and the presence of hypertension (Figures 1 and 2).

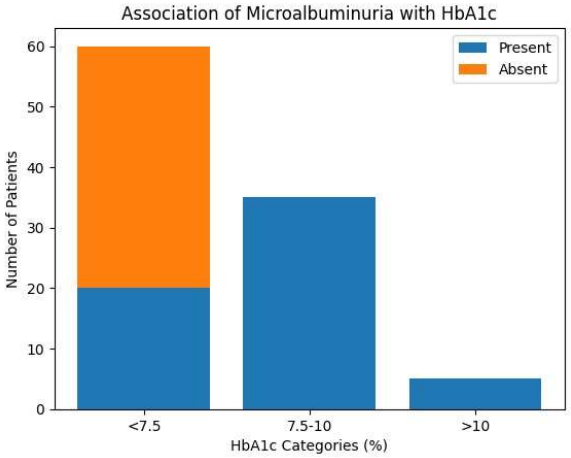

Figure 2: Association of microalbuminuria with HbA1c

CORRELATION BETWEEN HBA1C AND MICROALBUMINURIA

A strong positive correlation was observed between HbA1c and urine albumin levels ($r = 0.914$, $p < 0.001$). Patients with HbA1c <7.5% showed significantly lower albumin excretion, whereas patients with HbA1c >10% showed markedly increased albumin levels. The severity of microalbuminuria increased proportionally with increasing HbA1c categories (Figure 3).

ASSOCIATED RISK FACTORS

Patients with poor glycemic control also demonstrated dyslipidemia, higher body mass index, and increased prevalence of hypertension. These factors further contribute to renal risk in T2DM patients.

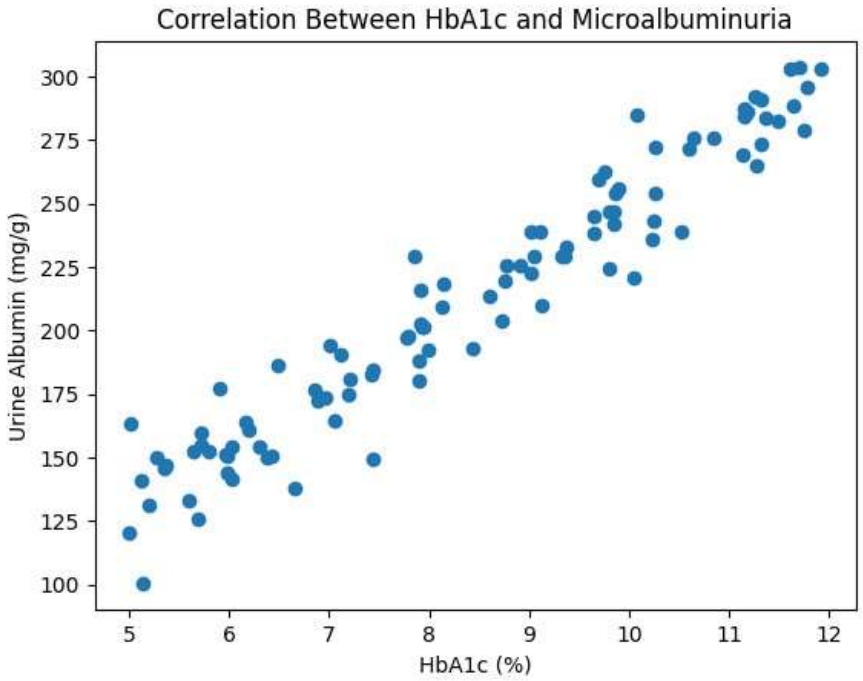

Figure 3: Correlation between HbA1c and microalbuminuria

DISCUSSION

Diabetic nephropathy remains one of the most common causes of end-stage renal disease worldwide. Early detection through microalbuminuria screening plays a critical role in preventing disease progression.[2]

In the present study, microalbuminuria was observed in 60% of patients, indicating significant early renal involvement among patients with type 2 diabetes mellitus. Similar findings have been reported in previous studies evaluating the relationship between glycemic control and albuminuria.[7-9]

Chronic hyperglycemia induces multiple metabolic and hemodynamic changes, including increased formation of advanced glycation end products and oxidative stress, which contribute to glomerular damage.[3-6]

The present study demonstrated a strong positive correlation between HbA1c and urine albumin levels ($r = 0.914$), suggesting that worsening glycemic control is associated with increased risk of nephropathy. These findings are consistent with earlier studies that established HbA1c as an important predictor of microvascular complications.[8,12] Screening strategies recommended by the American Diabetes Association and Kidney Disease: Improving Global Outcomes emphasize early detection and aggressive glycemic control to reduce renal complications.[10,11]

Standard internal medicine references such as Harrison's Principles of Internal Medicine also highlight the importance of maintaining optimal HbA1c levels to prevent diabetic nephropathy.[14]

Thus, the findings of the present study support the role of HbA1c as a reliable marker for predicting early renal involvement in type 2 diabetes mellitus.

LIMITATIONS

The limitations of this study include small sample size, cross-sectional design that cannot establish a causal relationship, and single-center study design. Further multicenter longitudinal studies are required to validate these findings.

CONCLUSION

This study demonstrates a strong and statistically significant correlation between HbA1c levels and microalbuminuria in patients with type 2 diabetes mellitus. Poor glycemic control is associated with increased prevalence and severity of microalbuminuria, indicating early renal involvement.

Routine screening for microalbuminuria along with strict glycemic control should be emphasized in all diabetic patients to prevent progression to diabetic nephropathy and chronic kidney disease.

REFERENCES

1. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2009;32(Suppl 1):S62-S67.
2. Zelmanovitz T, Gerchman F, Balthazar AP, Thomazelli FC, Matos JD, Canani LH. Diabetic nephropathy. Diabetol Metab Syndr. 2009;1:10.
3. Brownlee M. Biochemistry and molecular cell biology of diabetic complications. Nature. 2001;414:813-820.

4. Vlassara H, Fuh H, Makita Z, Cerami A, Bucala R. Advanced glycation end products and diabetic complications. Proc Natl Acad Sci USA. 1992;89:12043-12047.
5. Bucala R, Tracey KJ, Cerami A. Advanced glycosylation products and endothelial dysfunction. J Clin Invest. 1991;87:432-438.
6. Greene DA. Pathogenesis of diabetic complications. Metabolism. 1988;37:25-29.
7. Perkins BA, Ficociello LH, Silva KH, Warram JH, Krolewski AS. Regression of microalbuminuria in type 1 diabetes. N Engl J Med. 2003;348:2285-2293.
8. Hovind P, Tarnow L, Rossing K, Rossing P, Larsen N, Parving HH. Predictors for development of microalbuminuria. BMJ. 2004;328:1105.
9. Afkarian M, Zelnick LR, Hall YN, et al. Clinical manifestations of kidney disease among US adults with diabetes. JAMA. 2016;316:602-610.
10. American Diabetes Association. Microvascular complications and foot care. Diabetes Care. 2017;40:S88-S98.
11. Kidney Disease: Improving Global Outcomes (KDIGO). Clinical practice guideline for diabetes and CKD. Kidney Int Suppl. 2020.
12. Alicic RZ, Rooney MT, Tuttle KR. Diabetic kidney disease. Clin J Am Soc Nephrol. 2017;12:2032-2045.
13. Banday MZ, Sameer AS, Nissar S. Pathophysiology of diabetes. Avicenna J Med. 2020;10:174-188.
14. Jameson JL, Fauci AS, Kasper DL, et al. Harrison's Principles of Internal Medicine. 20th ed. McGraw Hill; 2018.