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Glycemic Control and Duration of Diabetes in Relation to Albuminuria Progression in Type 2 Diabetes

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Abstract

Background: Diabetic kidney disease (DKD) is a progressive kidney disease linked to diabetes mellitus and a primary cause of renal failure worldwide. Early renal involvement is commonly detected through microalbuminuria, which indicates subtle glomerular damage before advanced deterioration occurs. Glycated hemoglobin (HbA1c) provides a reliable measure of long-term blood glucose control and reflects overall metabolic regulation. This study was designed to explore the relationship between microalbuminuria, HbA1c levels, and duration of diabetes, and to evaluate their combined significance in detecting patients at risk for the development of diabetic kidney disease.

Materials and Methods: A case control study was carried out on 120 Individuals diagnosed with type 2 diabetes mellitus who visited Al Najaf Specialized Center for Diabetic and Endocrinology center, Al Hakeem General Hospital and Al Sadar Teaching Hospital in Najaf, Iraq hospital. Patients were stratified according to the measurements of the urinary albumin to creatinine ratio (UACR). HbA1c levels were measured by the fully automated AFIAS system, urinary albumin to creatinine ratio (UACR) using the fully Automated clinical chemistry analyzer [Cobas C 311(Hitachi High-Technologies Corp. Tokyo Japan)]. Statistical analysis included ANOVA test and chi-squared, Pearson correlation to determine the relationship between HbA1c and Duration of DM and albuminuria.

Results: The mean age of the participants was 55.58 ± 7.95 years, with an equal ratio between males and females. A significant positive association was noticed between albuminuria and HbA1c ($r = 0.382$, $p < 0.001$), Duration of DM ($r = 0.411$, $p < 0.001$). The prevalence of moderate to severe albuminuria was significantly higher in patients with a diabetes duration of >10 years and HbA1c >8% than in those with a diabetes duration of <5 years and HbA1c <7%.

Conclusion: The study indicated a positive association between albuminuria and HbA1 and diabetes duration. Furthermore the study show a higher risk of nephropathy are associated with poor glycemic control and longer diabetes duration.

More Information

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Keywords:

Diabetic kidney disease (DKD),
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Introduction

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from insulin resistance and/or impaired insulin secretion. It represents one of the most prevalent non-communicable diseases worldwide and contributes substantially to global morbidity and mortality, particularly in low- and middle-income countries [1]. The International Diabetes Federation

estimates that 853 million people worldwide will have diabetes by 2050 [2].

Diabetic nephropathy (DN), a major cause of chronic kidney disease and end-stage renal failure worldwide, is still one of the most severe and incapacitating long-term complications of type 2 diabetes [3]. The earliest clinically detectable indicator of diabetic renal involvement is generally accepted to be microalbuminuria, which is defined as a urinary albumin excretion rate of 30 to 300 mg/day [4]. Prior to a noticeable drop in glomerular filtration rate, it indicates early endothelial dysfunction and elevated glomerular permeability [5]. In people with type 2 diabetes, persistent microalbuminuria is strongly linked to an increased risk of cardiovascular morbidity and mortality in addition to being predictive of progressive renal impairment [6].

The duration of diabetes is an important determinant in the development and progression of diabetic nephropathy. Prolonged exposure to hyperglycemia over time accelerates structural and functional alterations in the renal microvasculature, thereby increasing the likelihood of microalbuminuria and overt nephropathy. Several clinical studies have demonstrated that a longer duration of T2DM is significantly associated with a higher prevalence of microalbuminuria and other microvascular complications [7]. These findings emphasize the importance of early diagnosis and sustained metabolic control to mitigate long-term renal damage.

Effective glycemic control remains central to the management and prognosis of T2DM. Glycated hemoglobin (HbA1c) is considered the most reliable indicator of long-term glycemic status, reflecting average blood glucose levels over the preceding two to three months [8]. Chronic hyperglycemia promotes oxidative stress, which plays a critical role in the pathogenesis of diabetes-related complications, including nephropathy, neuropathy, and cardiovascular disease [9]. Numerous studies have demonstrated a significant association between poor glycemic control and the development of microvascular complications, particularly diabetic nephropathy [7]. Despite this established relationship, the extent to which HbA1c correlates with microalbuminuria and its potential utility as a predictor of DN progression remains an area of ongoing investigation. Kidney disease in patients with T2DM is strongly linked to increased mortality risk, underscoring the need for timely detection and intervention [3].

The current study intends to determine the relationship between glycated hemoglobin (HbA1c) levels and microalbuminuria among patients with Type 2 Diabetes Mellitus, and to assess whether poor glycemic control and longer duration of diabetes are significantly associated with albuminuria.

Materials and Methods

This case-control study included 120 participants that were diagnosed with type 2 diabetes mellitus (T2DM) according to the criteria established by the American Diabetes Association (ADA) [12]. Based on the measurements of the urinary albumin to creatinine ratio (UACR), the patients were subsequently organized into the following groups: DN1 (Individuals diagnosed with type 2 diabetes without nephropathy with normal urinary albumin to creatinine ratio (UACR) <30 mg/g; 40 patients), DN2 (Individuals diagnosed with type 2 diabetes with nephropathy with urinary albumin to creatinine ratio (UACR) 30-300 mg/g; 40 patients). And DN3 (Individuals diagnosed with type 2 diabetes with nephropathy with urinary albumin to creatinine ratio (UACR) ≥ 300 mg/g; 40 patients).

Exclusion criteria consisted of individuals diagnosed with type-1 diabetes and those experiencing gestational diabetes, patients with anemia, patients with heart disease, patients with liver failure, patients with malignant disease and patients with Chronic kidney disease of non diabetic origin. The study took place at Al Najaf Specialized Center for Diabetic and Endocrinology center, Al Hakeem General Hospital and Al Sadar Teaching Hospital in Najaf, Iraq, between April 2025 and August 2025. All participants in this study have provided their agreement by signing a written consent form. Permission was granted by the Information Center for Research & Development in the Al-Najaf Health Department, which falls under the Ministry of Health, and located within Najaf Province and are in line with the declaration of Helsinki.

Clinical and Biochemical Measurements

Anthropometric measurements such as age, gender, duration of diabetes, height and weight were documented. The body mass index (BMI) is calculated using the formula for weight /height^2. Blood samples were collected after an overnight fast to measure Glycated hemoglobin (HbA1c) using the fully automated AFIAS system and urine samples were obtained for the measurement of urinary albumin to creatinine ratio (UACR) using the fully Automated clinical chemistry analyzer [Cobas C311(Hitachi High-Technologies Corp. Tokyo Japan)].

Statistical Analysis

All data were entered into Microsoft Excel and were analyzed by using SPSS version 27 and the results were expressed as Mean ±SD and percentages. ANOVA and Chi-squared, were used to assess the disparities among groups. Pearson's correlations was used to find out the correlation coefficient (r-value) among HbA1c and Duration of DM with albuminuria**.** A P value of less than 0.05 was considered as the significance threshold.

Results

The current study comprising 120 patients with type 2 diabetes mellitus. The average age of the study

participants was 55.58 ± 7.95 years. There was an equal gender distribution, comprising ratio 60 males (50%) and 60 females (50%).

From Table 1, the mean HbA1c levels increased progressively across the albuminuria groups. Patients with normoalbuminuria had a mean HbA1c of 8.08 ± 1.1, compared to 9.66 ± 1.85 in the microalbuminuria group and 9.67 ± 2.18 in the macroalbuminuria group. The difference between groups was statistically significant ($p < 0.001$). Mean duration of diabetes also showed statistically significant difference across the groups ($p < 0.001$). The mean duration was 8.2 ± 4.5 years in normoalbuminuria, and 9.8 ± 4.5 years in microalbuminuria, and 11.8 ± 5.4 years in macroalbuminuria. The longest duration of diabetes was observed in patients with macroalbuminuria group.

Table 1: Comparison of HbA1c and Duration of DM Levels across Albuminuria Groups

Group	HbA1c (%) (Mean ± SD)	Duration of DM (Mean ± SD)
Normoalbuminuria	8.08 ± 1.1	8.2 ± 4.5
Microalbuminuria	9.66 ± 1.85	9.8 ± 4.5
Macroalbuminuria	9.67 ± 2.18	11.8 ± 5.4
p-value	**<0.001**	**<0.001**

Albuminuria was found to positively correlate with HbA1c levels and duration of diabetes mellitus (r = 0.382, <
0.001), (r = 0.411, < 0.001), indicating that higher levels of albuminuria are linked to poor glycemic control and diabetes duration. Table 2 displays the distribution of patients based on HbA1c categories and associated albuminuria status.

Table 2: Distribution of Patients by HbA1c According to Albuminuria Groups

HbA1c Category (%)	Normoalbuminuria	Microalbuminuria	Macroalbuminuria	Total
Optimal control <7	8	3	4	15
Acceptable control 7–8	14	5	6	25
Poor control >8	18	32	30	80
Total	40	40	40	120

From Table 2, a greater proportion of patients with HbA1c >8 % were observed in the microalbuminuria and macroalbuminuria groups compared with those with HbA1c <7%.

Table 3: Distribution of Patients by Duration of DM According to Albuminuria Groups

Duration of DM	Normoalbuminuria	Microalbuminuria	Macroalbuminuria	Total
<5	4	2	0	6
5–10	25	20	18	63
>10	11	18	22	51
Total	40	40	40	120

From Table 3, it is shown that patients with duration diabetes of 5–10 years and >10% years were represented across all albuminuria groups, whereas no cases of macroalbuminuria were observed in patients with duration of <5 years.

Discussion

The current study showed that among patients with type 2 diabetes mellitus (T2DM), glycated hemoglobin (HbA1c) levels and albuminuria were significantly positively correlated. Patients with higher HbA1c levels also had higher levels of macroalbuminuria and microalbuminuria, suggesting that renal involvement is closely linked to poor glycemic control. These results align with previous research demonstrating that a higher risk of developing diabetic nephropathy is linked to elevated HbA1c levels [4,5,10].

Analysis of HbA1c categories further strengthens this association. Among patients with optimal glycemic control (HbA1c <7%), only 3 had microalbuminuria and 4 had macroalbuminuria, compared with 8 patients who remained normoalbuminuric. In contrast, among those with poor glycemic control (HbA1c >8%), 32 patients had microalbuminuria and 30 had macroalbuminuria, while only 18 remained normoalbuminuric. This clear shift toward higher albuminuria categories with increasing HbA1c demonstrates the impact of inadequate glycemic control on renal status. According to the American Diabetes Association (ADA), HbA1c ≥7.0% reflects

suboptimal glycemic control and is associated with increased risk of microvascular complications, particularly nephropathy [1]. Similar findings were reported by Idowu et al., who identified higher HbA1c levels as independent predictors of urinary albumin excretion [7].

Microalbuminuria is generally acknowledged as an early marker of glomerular injury in diabetes and predicts progressive renal damage [11]. Asghar et al, described microalbuminuria as the “tip of the iceberg” in T2DM, emphasizing its role as an early indicator of underlying microvascular pathology [11]. The progressive increase in albuminuria across HbA1c categories in this study affirms the importance of rigorous glycemic management in postponing renal complications.

Duration of diabetes also showed a clear association with albuminuria severity. No cases of macroalbuminuria were observed among patients with diabetes duration less than five years. In contrast, among those with duration greater than 10 years, 22 patients had macroalbuminuria and 18 had microalbuminuria, compared with only 11 patients remaining normoalbuminuric. Patients with duration between 5–10 years were distributed across all albuminuria groups, but the proportion of micro- and macroalbuminuria increased with longer duration. These findings indicate that prolonged exposure to hyperglycemia contributes cumulatively to renal microvascular damage [11].

The association between longer duration of diabetes and nephropathy is well documented. Asghar et al. reported significantly longer diabetes duration in patients with albuminuria [11]. Similarly, Varghese et al. demonstrated a significant relationship between duration of diabetes and prevalence of microalbuminuria [12]. Although Sana et al. observed only a weak correlation between urinary albumin creatinine ratio (UACR) and duration of diabetes [13], broader evidence supports the progressive impact of long-standing diabetes on renal function. Jin et al. showed that longer duration of diabetes was associated with declining renal function, reinforcing the concept of time-dependent renal deterioration [14].

The combined effect of elevated HbA1c and longer disease duration suggests a cumulative and synergistic impact on renal injury. Patients with persistently poor glycemic control over extended periods are at particularly high risk for progression from microalbuminuria to macroalbuminuria. These findings underscore the importance of early diagnosis, sustained glycemic management, and regular screening for albuminuria in patients with T2DM [11].

Although this study is limited by its case-control design and modest sample size, the distribution patterns observed in Tables 2 and 3 strengthen the evidence linking poor glycemic control and longer diabetes duration with worsening albuminuria.

Conclusion

In conclusion, both elevated HbA1c levels and prolonged duration of T2DM are significantly associated with increased albuminuria. Strict glycemic control and early monitoring remain essential strategies to reduce the burden of diabetic nephropathy.

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Ethical Approval

The Scientific Committee of the College of Medicine at the University of Basrah granted ethical clearance. Additionally, the hospital ethics board approved this study. All participants provided written informed consent after obtaining detailed information about the study's aims and methodologies.

Author Contributions

The conception, design and manuscript preparation of the study was contributed equally by all authors.

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References

[1] American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care.* 2014;37(Suppl 1):S81–S90. doi:10.2337/dc14-S081.

[2] International Diabetes Federation. *IDF Diabetes Atlas.* 11th ed. Brussels (Belgium): International Diabetes Federation; 2025, https://diabetesatlas.org/media/uploads/sites/3/2025/04/IDF_Atlas_11th_Edition_2025.pdf.

[3] Afkarian M, Sachs MC, Kestenbaum B, Hirsch IB, Tuttle KR, Himmelfarb J, et al. Kidney disease and increased mortality risk in type 2 diabetes. *J Am Soc Nephrol.* 2013;24(2):302–308. doi:10.1681/ASN.2012070718.

[4] Karar T, Alniwaider RA, Fattah MA, Al Tamimi W, Alanazi A, Qureshi S. Assessment of microalbuminuria and albumin creatinine ratio in patients with type 2 diabetes mellitus. *J Nat Sci Biol Med.* 2015;6(Suppl 1):S89–92. doi:10.4103/0976-9668.166095.

[5] Khadka B, Tiwari ML, Timalsina B, Risal P, Gupta S, Acharya D. Prevalence and factors associated with microalbuminuria among type 2 diabetic patients: A hospital-based study. *JNMA J Nepal Med Assoc.* 2018;56(209):516–21. doi:10.31729/jnma.3477.

[6] Jatoi NA, Said AH, Al-Ghamdi MS, Al-Abdulmhsin MF, Bin-Jaban RA, Al-Tayeb JA, et al. Prevalence of microalbuminuria and cardiovascular risk factors in patients with diabetes mellitus type II in Al-Khobar, Kingdom of Saudi Arabia. *Cureus.* 2022;14(10):e29808. doi:10.7759/cureus.29808.

[7] Idowu AA, Ajose AO, Adedeji AT, Adegoke AO, Jimoh KA. Microalbuminuria, other markers of nephropathy and biochemical derangements in type 2 diabetes mellitus: relationships and determinants. *Ghana Med J.* 2017;51(2):56–63. doi:10.4314/gmj.v51i2.3.

[8] Nathan DM, Singer DE, Hurxthal K, Goodson JD. The clinical information value of the glycosylated hemoglobin assay. *N Engl J Med.* 1984;310(6):341–346. doi:10.1056/NEJM198402093100601.

[9] Maritim AC, Sanders RA, Watkins JB 3rd. Diabetes, oxidative stress, and antioxidants: a review. *J Biochem Mol Toxicol.* 2003;17(1):24–38. doi:10.1002/jbt.10058.

[10] Karar T, Alhammad RI, Fattah MA, Alanazi A, Qureshi S. Relation between glycosylated hemoglobin and lipid and thyroid hormone among patients with type 2 diabetes mellitus at King Abdulaziz Medical City, Riyadh. J Nat Sci Biol Med. 2015;6(Suppl 1):S75–9. doi:10.4103/0976-9668.166091

[11] Asghar S, Asghar S, Mahmood T, Bukhari SMH, Mumtaz MH, Rasheed A. Microalbuminuria as the tip of iceberg in type 2 diabetes mellitus: prevalence, risk factors, and associated diabetic complications. Cureus. 2023;15(8):e43190. doi:10.7759/cureus.43190

[12] Varghese A, Deepa R, Rema M, Mohan V. Prevalence of microalbuminuria in type 2 diabetes mellitus at a diabetes centre in southern India. Postgrad Med J. 2001 Jun;77(908):399-402. doi: 10.1136/pmj.77.908.399. PMID: 11375456; PMCID: PMC1742050.

[13] Sana MA, Chaudhry M, Malik A, Iqbal N, Zakiuddin A, Abdullah M. Prevalence of microalbuminuria in type 2 diabetes mellitus. Cureus. 2020;12(12):e12318. doi:10.7759/cureus.12318

[14] Jin X, Yang X, Xu Y, Liang J, Liu C, Guo Q, et al. Differential correlation between time in range and eGFR or albuminuria in type 2 diabetes. Diabetol Metab Syndr. 2023;15(1):92. doi:10.1186/s13098-023-01071-4