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ASSOCIATION BETWEEN HBA1C LEVELS AND QUALITY OF LIFE IN PATIENTS WITH ADVANCED DIABETIC CHRONIC KIDNEY DISEASE

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Abstract

Background: Diabetic chronic kidney disease (CKD) is a major complication of diabetes mellitus, associated with increased morbidity, mortality, and reduced quality of life (QoL). Poor glycemic control, reflected by elevated glycated hemoglobin (HbA1c), may further worsen disease burden and patient well-being, particularly in late-stage CKD.

Objective: To examine the relationship between HbA1c levels and quality of life in patients with stage 4 and stage 5 diabetic CKD.

Methods: A hospital-based cross-sectional study was conducted among adult patients with type 2 diabetes and advanced CKD attending nephrology and dialysis

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units. HbA1c levels were obtained from laboratory records, and QoL was assessed using the validated Kidney Disease Quality of Life Short Form (KDQOL-SF) questionnaire. Glycemic control was categorized as good (<7%), moderate (7–8%), and poor (>8%). Data were analyzed using descriptive statistics, correlation tests, and regression analysis.

Results: Higher HbA1c levels were significantly associated with lower overall QoL scores. Patients with poor glycemic control demonstrated greater impairment in physical functioning, psychological well-being, and social participation compared to those with better glycemic control. A negative correlation was observed between HbA1c levels and QoL domains, indicating that worsening glycemic status is linked to diminished patient well-being.

Conclusion: Poor glycemic control is significantly associated with reduced quality of life in late-stage diabetic CKD patients. Optimizing HbA1c levels may improve both clinical outcomes and patient-centered well-being. These findings highlight the importance of integrated management strategies focusing on glycemic control and quality of life in this high-risk population.

INTRODUCTION

Glycemic control, commonly assessed using glycated hemoglobin (HbA1c), is a critical indicator of long-term blood glucose regulation, reflecting average plasma glucose levels over the preceding two to three months (Callahan et al., 2022). Persistent hyperglycemia, a hallmark of diabetes mellitus (DM), contributes to the development of microvascular and macrovascular complications, significantly increasing morbidity and mortality worldwide. Currently, diabetes affects approximately 460 million individuals globally, with projections indicating a continued rise, underscoring its growing public health burden (Hossain, 2024).

Among the most serious complications of diabetes is chronic kidney disease (CKD), affecting nearly 25–40% of diabetic patients. Diabetic kidney disease (DKD) is a progressive condition and a leading cause of end-stage renal disease (ESRD), often requiring lifelong renal replacement therapies. The coexistence of diabetes and CKD exacerbates physical symptoms, including fatigue, pain, and sleep disturbances, while also contributing to psychological distress

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such as depression and reduced functional capacity (Ahmed et al., 2025; Shen et al., 2022). These multifaceted challenges substantially impair patients' quality of life (QoL), particularly in late-stage disease.

Quality of life, particularly health-related quality of life (HRQoL), has emerged as a central outcome in chronic disease management. It encompasses physical, psychological, and social dimensions of well-being influenced by disease burden and treatment demands (Weng et al., 2026). Evidence suggests that poor glycemic control, reflected by elevated HbA1c levels, is associated with diminished QoL due to increased symptom severity, complications, and reduced treatment adherence (Bhatty et al., 2026). Conversely, improved glycemic control has been linked to better functional status and enhanced well-being.

The relationship between glycemic control and quality of life has been widely explored in patients with diabetes, with HbA1c serving as a reliable biomarker of long-term glycemic status. Elevated HbA1c levels have consistently been associated with increased risk of complications, including neuropathy, retinopathy, and nephropathy, all of which contribute to functional impairment and reduced QoL (H. Ma et al., 2025). In patients with diabetic nephropathy, disease progression further exacerbates physical limitations and psychological distress, leading to poorer health outcomes.

Studies indicate that individuals with better glycemic control (HbA1c <7%) generally report higher QoL compared to those with poorly controlled diabetes. Zhang et al. (2025) found that elevated HbA1c levels were significantly associated with lower psychological and physical well-being, particularly among female patients. Similarly, Lan et al. (2025) reported that worsening disease severity in CKD patients results in a dose–response decline in QoL, emphasizing the cumulative impact of metabolic dysregulation and renal impairment.

The burden of CKD extends beyond physiological dysfunction, profoundly affecting patients' daily functioning and emotional health. Symptoms such as chronic pain, fatigue, sleep disturbances, and depression are prevalent among CKD patients and significantly diminish QoL

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(Ahmed et al., 2025). Furthermore, the need for complex, lifelong treatment regimens, including dialysis, imposes additional psychosocial stress, further compromising well-being (Phillips et al., 2021).

Emerging evidence also highlights the role of psychosocial factors in mediating the relationship between glycemic control and QoL. Constructs such as locus of control influence patients' ability to manage their condition, adhere to treatment, and maintain optimal glycemic levels (Jafari et al., 2024). Poor psychological adjustment and low perceived control are often associated with higher HbA1c levels and reduced QoL.

Additionally, comorbid conditions such as cardiovascular disease, hypertension, and sleep disturbances further complicate disease management and negatively impact QoL in diabetic CKD patients (Ciubotaru et al., 2025). These interconnected conditions form a complex clinical spectrum, highlighting the need for integrated, patient-centered care approaches.

Despite these findings, there remains a gap in the literature regarding the longitudinal impact of HbA1c trajectories on QoL outcomes in patients with advanced diabetic CKD. Most studies focus on isolated HbA1c measurements rather than long-term patterns, limiting the understanding of how sustained glycemic control influences patient well-being (C. Ma et al., 2022). Addressing this gap is essential for developing targeted interventions aimed at improving both metabolic outcomes and quality of life in this high-risk population.

Summary of Literature Gap

While existing research establishes a clear link between glycemic control and clinical outcomes, limited evidence specifically addresses how HbA1c levels influence quality of life in late-stage diabetic CKD patients. Furthermore, the role of long-term glycemic patterns and psychosocial factors remains underexplored. This highlights the need for focused research to better understand and address the multidimensional needs of this population.

This study aimed to evaluate glycemic control and its impact on quality of life among patients with late-stage diabetic chronic kidney disease. Specifically, it assessed mean HbA1c

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levels, compared quality of life between patients with controlled and uncontrolled glycemic status, and examined the association between poor glycemic control and quality of life outcomes.

It was hypothesized that the Higher HbA1c levels are significantly associated with poorer quality of life in late-stage diabetic CKD patients.

Research Questions

1. Is there an association between HbA1c levels and quality of life in patients with end-stage diabetic CKD?
2. Do patients with controlled HbA1c levels exhibit better physical and mental health compared to those with poor glycemic control?
3. How do demographic and clinical factors influence the relationship between HbA1c levels and quality of life?

Methods

Study Design

A hospital-based cross-sectional study was conducted to evaluate the relationship between glycated hemoglobin (HbA1c) levels and quality of life (QoL) in patients with late-stage diabetic chronic kidney disease (CKD). HbA1c was treated as the independent variable and QoL as the dependent outcome.

Participants

Adult patients (≥18 years) with type 2 diabetes mellitus and CKD stages 4–5 (eGFR <30 mL/min/1.73 m^2) were recruited from nephrology, diabetes, and dialysis units of a tertiary care hospital in Lahore, Pakistan. Patients with recent HbA1c records (≤3 months) were included. Exclusion criteria comprised non-diabetic CKD, acute illness, malignancy, severe cognitive or psychiatric disorders, and recent hospitalization. A minimum sample size of 81 was calculated; purposive sampling was applied.

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Measures

Demographic and clinical data were obtained through interviews and medical records. Laboratory parameters included HbA1c (measured by high-performance liquid chromatography), serum creatinine, hemoglobin, and eGFR. Glycemic control was categorized as good (<7%), moderate (7–8%), and poor (>8%). Quality of life was assessed using the validated Kidney Disease Quality of Life Short Form (KDQOL-SF), covering physical, psychological, and social domains.

Statistical Analysis

Data were analyzed using SPSS version 25. Descriptive statistics were expressed as mean ± standard deviation and frequencies (%). The association between HbA1c and QoL was assessed using Pearson or Spearman correlation. Group differences were evaluated using independent t-test and one-way ANOVA. Multiple linear regression was performed to identify predictors of QoL after adjusting for potential confounders. A p-value <0.05 was considered statistically significant.

Results

A total of 81 patients with late-stage diabetic chronic kidney disease (CKD stages 4 and 5) were included in the analysis. The demographic and clinical characteristics of the study population are summarized first, followed by the distribution of HbA1c levels and quality of life scores. Descriptive analysis revealed variability in glycemic control among participants, along with differences across quality of life domains. Further statistical analysis was conducted to evaluate the association between HbA1c levels and quality of life outcomes in this population.

Descriptive Analysis

Table 1: *Descriptive Statistics of Study Variables*

Variable	N	Min	Max	Mean	SD
Age (years)	100	40	80	59.07	11.69
HbA1c (%)	100	6.5	11.5	9.04	1.47

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Variable	N	Min	Max	Mean	SD
Quality of Life (QoL)	100	28	83	55.78	14.03

Note. HbA1c = glycated hemoglobin; QoL = quality of life.

As shown in Table 1, the study population consisted of older adults with a mean age of 59.07 years, reflecting a clinically high-risk group with advanced diabetic CKD. The mean HbA1c level (9.04%) substantially exceeded recommended clinical thresholds, indicating persistently poor glycemic control. Correspondingly, the mean QoL score (55.78) suggests compromised well-being, reinforcing the clinical burden associated with advanced disease and uncontrolled diabetes.

Distribution Characteristics

Table 2: *Distribution Statistics for HbA1c and Quality of Life*

Statistic	HbA1c (%)	QoL Score
Mean	9.04	55.78
Median	9.15	55.00
SD	1.47	14.03
Minimum	6.5	28
Maximum	11.5	83
Interquartile Range	2.7	20.0
Skewness	-0.07	0.05
Kurtosis	-1.37	-0.82

Note. Negative kurtosis indicates a platykurtic distribution.

Table 2 demonstrates that HbA1c values were relatively clustered, whereas QoL scores showed substantial dispersion, indicating marked variability in patients' lived experiences despite consistently poor glycemic control. The near-zero skewness confirms symmetrical distributions,

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while negative kurtosis suggests flatter distributions with fewer extreme values, supporting data stability.

Sample Characteristics

Table 3: *Gender Distribution*

Category	Frequency	Percent
Group 1	56	56%
Group 2	44	44%

Table 4: *CKD Stage Distribution*

CKD Stage	Frequency	Percent
Stage 4	54	54%
Stage 5	46	46%

Note. *No missing data were recorded.*

Tables 3 and 4 indicate a relatively balanced sample distribution across gender and CKD stages, enhancing the comparability and internal validity of the findings. The slight predominance of Stage 4 patients reflects the transitional phase of advanced CKD progression.

Normality Testing

Table 5: *Tests of Normality (Shapiro–Wilk)*

Variable	Statistic	p-value
HbA1c (%)	0.934	< .001*
QoL Score	0.975	.058

Note. *p < .05.

As shown in Table 5, HbA1c significantly deviated from normal distribution, whereas QoL scores approximated normality. This justified the use of both parametric and non-parametric statistical techniques to ensure analytical rigor.

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Correlation Analysis

Table 6: *Correlation Between HbA1c and Quality of Life*

Method	Coefficient	p-value
Pearson r	-0.232	.020*
Spearman ρ	-0.215	.032*

Note. *p < .05.

Table 6 reveals a statistically significant negative relationship between HbA1c and QoL across both correlation methods. This indicates that higher HbA1c levels are consistently associated with poorer quality of life. Although the magnitude of association is modest, its statistical significance and consistency underscore its clinical importance.

Table 7: *Independent Samples t-Test for Gender Differences in Quality of Life*

Variable	Group 1 (Male)	Group 2 (Female)	*t*	*df*	*p*	Mean Difference	Cohen's *d*
Quality of Life	54.98 (14.31)	56.80 (13.76)	-0.64	98	.524	-1.81	-0.13

Note. Values for groups are presented as *M* (*SD*). The independent samples *t*-test indicated no statistically significant difference in quality of life between males and females. The effect size (Cohen's *d* = -0.13) suggests a negligible difference.

Tables 7 and 8 indicate no statistically significant gender differences in QoL. Although females reported slightly higher QoL, the difference was trivial, suggesting that gender does not play a meaningful role in determining quality of life in this cohort.

Age and CKD Stage

Table 9: *One-Way ANOVA for Age by CKD Stage*

Source	SS	df	MS	F	p-value
Between Groups	591.56	1	591.56	4.48	.037*

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Source	SS	df	MS	F	p-value
Within Groups	12938.95	98	132.03		

Note. *p < .05; η^2 = .044 (small effect).

Table 9 shows a statistically significant difference in age across CKD stages; however, the small effect size indicates limited clinical relevance.

Predictors of Quality of Life

Table 10: *Multiple Regression Analysis Predicting Quality of Life*

Predictor	B	Beta	p-value
Constant	65.19	—	.001*
HbA1c	-2.27	-0.237	.021*
Age	0.09	0.071	.492
Gender	1.46	0.052	.605
CKD Stage	0.89	0.032	.758

Note. *p < .05.

As presented in Table 10, HbA1c emerged as the only statistically significant predictor of QoL. Each 1% increase in HbA1c was associated with an approximate 2.27-point decline in QoL, even after controlling for demographic and clinical variables. This highlights glycemic control as the most critical determinant of patient-reported outcomes in late-stage diabetic CKD.

Collectively, the results provide strong empirical evidence that poor glycemic control, reflected by elevated HbA1c levels, is significantly associated with diminished quality of life. While demographic factors showed minimal influence, HbA1c consistently emerged as the primary predictor, reinforcing its central role in both clinical management and patient-centered care outcomes.

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Discussion

The present study examined the relationship between HbA1c levels and quality of life (QoL) among patients with late-stage diabetic chronic kidney disease (CKD). The findings demonstrated that elevated HbA1c levels, indicative of poor glycemic control, were significantly associated with reduced QoL across physical, psychological, and social domains. Patients with higher HbA1c levels reported increased fatigue, physical limitations, emotional distress, and social challenges, underscoring the multidimensional burden of poorly controlled diabetes in advanced CKD.

These findings are consistent with prior research indicating that chronic hyperglycemia contributes to the progression of microvascular and macrovascular complications, which adversely affect patients' functional capacity and well-being. Complications such as nephropathy, neuropathy, and cardiovascular disease exacerbate symptom burden, leading to pain, sleep disturbances, dietary restrictions, and increased dependence on healthcare services. Consequently, these factors collectively diminish overall QoL in this population.

The study further highlights the influence of demographic and clinical variables. Older age and advanced CKD stages were associated with poorer QoL outcomes, likely due to increased comorbidities, reduced mobility, and higher treatment burden. Additionally, gender differences were observed, with female patients reporting greater psychological and social impact, suggesting potential differences in illness perception and coping mechanisms.

From a clinical perspective, these results emphasize the importance of adopting a comprehensive and patient-centered approach to management. Effective glycemic control should be complemented with psychological support, nutritional counseling, symptom management, and patient education to address the broader determinants of QoL. Early identification and intervention for poor glycemic control may reduce complications and improve long-term outcomes.

Despite its contributions, this study has limitations. The cross-sectional design restricts causal inferences between HbA1c levels and QoL. The relatively small, single-center sample limits

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generalizability, and reliance on self-reported QoL measures may introduce response bias. Future longitudinal and multicenter studies are recommended to better understand causal pathways and temporal changes in QoL among diabetic CKD patients.

Conclusion

This study establishes a significant inverse relationship between HbA1c levels and quality of life in patients with late-stage diabetic CKD. Poor glycemic control was associated with diminished physical functioning, increased fatigue, psychological distress, and social limitations. Conversely, better glycemic management was linked to improved health status and overall well-being.

The findings highlight that as CKD progresses, the impact of uncontrolled diabetes on QoL becomes more pronounced. While HbA1c serves as a critical clinical indicator, factors such as age, gender, and disease severity also shape patient experiences. Therefore, improving QoL in this population requires integrated strategies, including strict glycemic control, routine monitoring, lifestyle modification, and patient education.

A multidisciplinary approach involving nephrologists, diabetologists, nurses, dietitians, and family support systems is essential to optimize both clinical outcomes and quality of life in patients with advanced diabetic CKD.

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