



The Relationship of HbA1c Levels and Degree of Diabetic Nephropathy in Patients with Type 2 Diabetes Mellitus in RSI Jemursari Surabaya

Putri Dhiya Ayu Shofiyah,^{1*} Lea Maera Shanty,² Marselli Widya Lestari³

¹ Undergraduate Medical Program, Faculty of Medicine, Universitas Nahdlatul Ulama Surabaya, Indonesia

² Department of Internal Medicine, Faculty of Medicine, Universitas Nahdlatul Ulama Surabaya, Indonesia

³ Department of Public Health and Preventive Medicine, Faculty of Medicine, Universitas Nahdlatul Ulama Surabaya, Indonesia

*Corresponding Author: 5130021055@student.unusa.ac.id

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ARTICLE INFO	ABSTRACT
Keywords: Diabetes Mellitus Type 2, HbA1c, Diabetic Nephropathy, GFR Submitted: Feb 3rd 2025 Reviewed: Feb 23th 2025 Accepted: July 29th 2025	Introduction: Type 2 diabetes mellitus is a metabolic disorder frequently associated with long-term complications. One of the most common microvascular complications is diabetic nephropathy, a condition that significantly contributes to morbidity and mortality among patients. A reduced glomerular filtration rate (GFR) reflects a more advanced stage of nephropathy, and when accompanied by elevated HbA1c levels, it indicates poor glycemic control and a greater risk of diabetes-related complications. Objective: To prove the relationship between HbA1c levels and the degree of diabetic nephropathy Methods: This study is an analytical observational research with a cross-sectional approach. The population in this study consists of medical record data from patients with type 2 diabetes mellitus at RSI Jemursari, totaling 946 patients. The sample was obtained using the Slovin formula, with a 10% margin of error, resulting in 90 samples. Sampling was done using the nonprobability sampling method of consecutive sampling. The statistical test uses the Spearman test in SPSS. Results: The significance value was <0.001 (<0.1), and the correlation coefficient was 0.416. The results of the Spearman statistical test demonstrate a significant relationship between the two variables, with a moderate quality of the relationship between them. Conclusions: A significant relationship was found between the HbA1c level variable and the degree of nephropathy in patients with type 2 diabetes mellitus, characterized by a correlation coefficient indicating a moderate quality of relationship.

Introduction

Type 2 Diabetes Mellitus, also known as Non-Insulin-Dependent Diabetes Mellitus (NIDDM), primarily affects adults. This form of diabetes is characterized by two

main insulin-related problems: insulin resistance, which impairs the body's ability to regulate blood sugar levels and dysfunction or damage to the beta cells in the pancreas. (Banday et al., 2020)

Complications are a common outcome for individuals who have been diagnosed with Type 2 Diabetes Mellitus for many years. This chronic condition inevitably leads to a variety of complications, including significant issues with blood vessels, both large (macrovascular) and small (microvascular), as well as neurological disorders (neuropathy). Macrovascular complications primarily affect the heart, brain, and larger blood vessels. In contrast, microvascular complications have a direct impact on the eyes, kidneys, and the small blood vessels involved in the nervous system. (Soelistijo, 2021)

Chronic kidney failure is a common microvascular complication associated with Type 2 Diabetes Mellitus, affecting approximately 35 to 45% of patients. Diabetic nephropathy, which refers to chronic kidney failure in these individuals, is a leading cause of death among those with Type 2 Diabetes Mellitus, particularly in cases where Diabetic nephropathy has progressed to end-stage renal failure. (Majid et al., 2020) This condition can significantly affect the lives of individuals with Type 2 Diabetes Mellitus, potentially resulting in disabilities and even death. (Oktaviani, Indriani, Kusuma, & Futriani, 2021) Recognizing these risks is crucial for effective management and prevention of further complications. (Soelistijo, 2021)

HbA1c is the most reliable indicator for managing blood sugar in patients with Type 2 Diabetes Mellitus. Higher HbA1c levels indicate an increased risk of complications associated with Type 2 Diabetes Mellitus. (Majid et al., 2020) The elevated HbA1c levels indicate high blood glucose levels over the past three months. Furthermore, elevated HbA1c levels may suggest that glucose has accumulated in the renal glomeruli through the circulatory system. This condition leads to an increase in pressure caused by hyperfiltration occurring within the glomerulus. Consequently, this leads to an increase in the glomerular filtration rate. This phenomenon signifies the early stage of Diabetic nephropathy. (Tarawifa et al., 2020)

Complications related to Type 2 Diabetes Mellitus can be effectively anticipated right from the moment a patient is diagnosed with Type 2 Diabetes Mellitus. An accurate diagnosis depends on reliable testing methods, particularly the HbA1c examination. By exploring the relationship between HbA1c as a biomarker for Type 2 Diabetes Mellitus and the biomarkers associated with potential complications, we can confidently predict the development of these complications in the future. This study examines a complication of Type 2 Diabetes Mellitus called Diabetic nephropathy. Researchers are investigating the relationship between HbA1c levels and

the glomerular filtration rate (GFR), a key indicator of this condition.

Methods

This research was conducted at the Islamic Hospital Jemursari Surabaya and has obtained ethical clearance from the hospital. The population of this study was obtained from the patient medical records at the hospital, which included patients diagnosed with Type 2 Diabetes Mellitus during the period from September 2022 to 2023, totaling 946 patients. Using Slovin's formula with a 10% margin of error, which is necessary to reduce the number of samples, 90 samples were generated for this study.

Sampling for this study employed non-probability techniques, specifically consecutive sampling methods. The statistical tests used in this study are univariate and bivariate. The univariate test is intended to observe the frequency distribution of each variable. In contrast, the bivariate test employs the Spearman correlation test to assess the relationship between the two variables, HbA1c and GFR. Additionally, cross-tabulation is used to determine the highest frequency of each level of HbA1c at each degree of Diabetic Nephropathy. A cross-sectional study is used for observational analytical studies.

Results and Discussion

Table 1 presents the characteristics of the respondents, including HbA1c levels, serum creatinine levels, age, and gender. In the HbA1c variable, most respondents were in Group 2 (6.1–7.9%), which accounted for 48.9% of the sample, followed by Group 4 ($\geq 9\%$) with 31.1%, Group 3 (8–8.9%) with 13.3%, and Group 1 (5–6%) with 6.7%.

Table 1. Respondent Characteristics

No.	Characteristic	Variable Categories	%
1.	HbA1c (%)	Group 1 (5 – 6%)	6.7
		Group 2 (6.1 – 7.9%)	48.9
		Group 3 (8 – 8.9%)	13.3
		Group 4 ($\geq 9\%$)	31.1
2.	Kreatinin (mg/dL)	Low (< 0.62)	0.9
		Normal (0.62 -1.10)	43.34
		High (> 1.10)	53.34
3.	Age (year)	≤ 59	43.3
		60 – 74	55.6
		≥ 75	1.1
4.	Gender	Women	53.34
		Men	46.67

Note: Both frequency and percentage represent each variable.

This distribution indicates that the majority of patients with type 2 diabetes mellitus in this study had suboptimal glycemic control, with only a small proportion achieving HbA1c levels within

the near-normal range. Clinically, HbA1c has long been recognized as the gold standard for monitoring and evaluating long-term glycemic control over the preceding three months in patients with type 2 diabetes mellitus. In addition, HbA1c is widely used as a biomarker to estimate and detect the risk of chronic complications at an early stage (Kurniawan & Boy, 2024). The predominance of respondents with HbA1c values above the normal range in this study is consistent with the general pattern observed in patients with long-standing type 2 diabetes, who frequently experience difficulties in maintaining stable glycemic control due to progressive β -cell dysfunction and chronic insulin resistance (Banday et al., 2020).

With regard to serum creatinine levels, 53.34% of respondents had elevated creatinine (>1.10 mg/dL), 43.34% were within the normal range (0.62–1.10 mg/dL), and only 0.9% had creatinine levels below 0.62 mg/dL. Creatinine is the end product of creatine phosphate metabolism in muscle and is excreted primarily through the kidneys. Progressive impairment of kidney function in patients with diabetic nephropathy disrupts creatinine excretion, leading to its accumulation in the blood (Gounden et al., 2024). Therefore, elevated serum creatinine in this study reflects reduced renal clearance and supports the presence of various degrees of kidney

dysfunction among patients. Serum creatinine is also an essential parameter in estimating glomerular filtration rate (GFR), which integrates several factors including age, gender, serum creatinine, and body weight. GFR estimation is fundamental to interpreting abnormal clinical and laboratory findings related to kidney disease. Accordingly, Kidney Disease: Improving Global Outcomes (KDIGO) guidelines recommend the measurement of serum creatinine as the initial step in GFR estimation and chronic kidney disease classification (Levey et al., 2020).

In terms of age distribution, the majority of respondents were in the 60–74-year age group (55.6%), followed by those aged ≤ 59 years (43.3%), and only 1.1% were ≥ 75 years old. These findings indicate that most of the study population belonged to the elderly age group. This is in line with the natural history of type 2 diabetes mellitus, in which the risk of developing the disease and its chronic complications increases with age. Elderly individuals are particularly vulnerable to metabolic disorders due to age-related physiological changes, comorbidities, and reduced organ reserve (Francisco et al., 2022). Previous research by Kusdiyah et al. (2021) reported that the incidence of diabetic nephropathy was most common in patients aged 60–64 years, suggesting that this age range represents a critical period during which long-term

hyperglycemia and other risk factors begin to manifest as chronic microvascular complications. The predominance of respondents aged 60–74 years in this study therefore strengthens the hypothesis that advancing age contributes significantly to the risk of diabetic nephropathy.

With regard to gender, 53.34% of the respondents were women and 46.67% were men. Several studies have shown that microvascular complications of type 2 diabetes mellitus, including diabetic nephropathy, may occur more frequently in women (Kautzky-Willer et al., 2023). This pattern is supported by the findings of Kusdiyah et al. (2021), who reported a higher proportion of diabetic nephropathy among female patients compared with males. One possible explanation is that postmenopausal women no longer produce adequate levels of estrogen, a hormone that previously exerted a protective effect against kidney damage. The loss of estrogen in older women may thus increase their susceptibility to kidney injury and accelerate the progression of nephropathy (Wahyuningsih et al., 2019). The higher proportion of female respondents in the present study is therefore consistent with the notion that older women with type 2 diabetes mellitus are at substantial risk of developing diabetic nephropathy.

The correlation analysis between HbA1c levels and GFR, as shown in Table 2,

revealed a Spearman correlation coefficient of 0.416 with a significance value of <0.001 ($p < 0.1$). This finding indicates a statistically significant relationship between HbA1c levels and the degree of diabetic nephropathy, with a correlation of moderate strength (0.26–0.50). In other words, higher HbA1c levels are associated with more advanced stages of nephropathy, as reflected by reduced GFR. From a pathophysiological perspective, persistent hyperglycemia leads to non-enzymatic glycation of proteins, oxidative stress, and hemodynamic changes within the glomerulus. These mechanisms contribute to glomerular hyperfiltration in the early stages, followed by progressive glomerulosclerosis, thickening of the glomerular basement membrane, and eventual decline in GFR (Majid et al., 2020; Tarawifa et al., 2020). The moderate positive correlation obtained in this study is in agreement with previous research demonstrating that poor glycemic control, as measured by elevated HbA1c, is closely related to the occurrence and progression of diabetic nephropathy.

The cross-tabulation between HbA1c groups and GFR categories (Table 3) further illustrates this relationship. In Group 1 (HbA1c 5–6%), most respondents were still in the GFR category 1 (≥ 90 mL/min/1.73 m²), indicating preserved kidney function. In contrast, in Group 2

(HbA1c 6.1–7.9%), there was a notable shift, with respondents distributed across GFR categories 1 to 4, including those with moderately to severely reduced GFR (30–59 and 15–29 mL/min/1.73 m²). This pattern became more apparent in Group 3 (HbA1c 8–8.9%) and Group 4 (HbA1c ≥9%), where a higher proportion of patients were concentrated in GFR categories 3 and 4, which correspond to moderate to severe decreases in kidney function. These findings imply that as HbA1c levels increase, patients are more likely to present with lower GFR values and more advanced stages of diabetic nephropathy. In practical terms, a given HbA1c level can therefore be used as an early indicator to predict the degree of nephropathy in patients with type 2 diabetes mellitus.

The results of this study are consistent with those of Majid et al. (2020), who reported a significant association between HbA1c levels and decreased GFR as well as proteinuria in patients with type 2 diabetes mellitus. Similarly, Tarawifa et al. (2020) found that higher HbA1c levels were associated with an increased risk of diabetic nephropathy. Collectively, these studies support the view that strict glycemic control is essential not only to prevent the onset of nephropathy but also to slow its progression once it has developed. From a clinical standpoint, this underscores the importance of regular HbA1c monitoring as an integral

part of routine care for patients with type 2 diabetes mellitus, especially those with additional risk factors such as advanced age, female sex, long duration of disease, hypertension, and dyslipidemia.

In addition to glycemic control, the present findings highlight the role of routine kidney function assessment in diabetes management. Given that serum creatinine and GFR can reveal early renal impairment even before overt clinical symptoms appear, periodic evaluation of these parameters is crucial. Early detection of reduced GFR enables timely intervention, such as optimization of blood glucose control, blood pressure management, and the use of renoprotective agents, which may delay or prevent progression to end-stage renal disease. However, in routine practice, it is still relatively uncommon to find patients with type 2 diabetes mellitus who regularly undergo both HbA1c and creatinine assessments. Barriers may include limited awareness, financial constraints, or the perception that such examinations are only necessary when symptoms arise.

Overall, the findings of this study reinforce the concept that HbA1c and GFR are interrelated markers that can be used together to stratify the risk of diabetic nephropathy. Higher HbA1c values tend to be accompanied by more advanced degrees of nephropathy, as demonstrated by lower

GFR categories and higher proportions of patients with impaired kidney function. These results strengthen the rationale for integrating routine HbA1c measurement and kidney function tests into standard diabetes care protocols at the primary and secondary healthcare levels. Regular

monitoring, accompanied by appropriate counseling and early therapeutic intervention, has the potential to reduce the burden of diabetic nephropathy, improve patients' quality of life, and decrease diabetes-related morbidity and mortality.

Table 2. Spearman Correlation

Correlations				
		HBA1C		GFR
Spearman's rho	HBA1C	Correlation Coefficient	1.000	.416**
		Sig. (2-tailed)	.	<.001
		N	90	90
	GFR	Correlation Coefficient	.416**	1.000
		Sig. (2-tailed)	<.001	.
		N	90	90

Table 3. Cross Tabulation

Cross Tabulation		GFR								Total	
		1 (≥90)		2 (60-89)		3 (30-59)		4 (15-29)			
HbA1c	1 (5 – 6 %)	4	66.7%	2	33.4%	0	0%	0	0%	6	6.67%
	2 (6.1 - 7.9%)	8	18.2%	20	45.5%	15	34.1%	1	2.3%	44	48.9%
	3 (8 – 8.9 %)	0	0%	4	33.4%	7	58.3%	1	8.34%	12	13.34%
	4 (≥9%)	1	3.6%	8	28.6%	19	67.86%	0	0%	28	31.12%
Total										90	100%

Conclusion

Different HbA1c levels correlate with varying stages of diabetic nephropathy. Understanding the Correlation between these variables is intended to enhance medical professionals' awareness of the risk of developing Nephropathy in

patients with Type 2 Diabetes Mellitus, , emphasizing the need for routine monitoring. It is recommended that patients undergo HbA1c testing every three months alongside creatinine evaluation for early detection of complications, supported by

health promotion programs such as periodic mass screening.

However, this study has several limitations that should be acknowledged to strengthen its academic rigor. The cross-sectional design precludes establishing causality, capturing only associations at a single time point. Reliance on medical records from a single center (RSI Jemursari) with a modest sample size (n=90) limits generalizability, while potential confounders like diabetes duration, hypertension control, and medication use were not fully adjusted. Future longitudinal studies with larger, multi-center samples and comprehensive confounder control are warranted to validate these findings and explore additional risk factors.

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