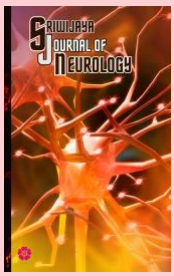

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The Relationship between Hba1c Levels and Body Mass Index with Severity of Diabetic Neuropathy

Muhammad Rauf[1*], Masyita Sari[1]

[3]Department of Neurology, Dr. M Djamil General Hospital, Padang, Indonesia

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***Corresponding author:**
Muhammad Rauf

E-mail address:
m.rauf76@gmail.com

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A B S T R A C T

Introduction: Diabetic neuropathy is the most common microvascular complication in diabetes mellitus patients. Diabetic neuropathy is known to be associated with conditions of hyperglycemia and obesity that occur in diabetic patients. Hyperglycemia in diabetic patients can be monitored through HbA1c levels. This study aimed to assess the relationship between HbA1C values and body mass index with the severity of diabetic neuropathy based on nerve conduction velocity examination. **Methods:** A study with a cross-sectional design with a total of 25 subjects with diabetes mellitus. The severity of diabetic neuropathy was determined based on Baba's diabetic neuropathy classification (BDC), degrees 0 to 4. In all study subjects, plasma HbA1c levels were examined, and body mass index was assessed. The relationship between categorical variables was tested with the chi-square test, and the relationship between numerical and categorical variables with a one-way ANOVA test, the value was considered statistically significant if the p-value <0.05. **Results:** The 25 subjects with diabetes found a mean age of 54.88 (±SD 8.918) years, with a gender distribution of 46.4% for women and 42.9% for men. The average HbA1c level was 8.9560 (± 2.21850), and the highest body mass index was obese (50%). There was a significant relationship between HbA1c levels and the severity of diabetic neuropathy based on electrophysiological examination ($p<0.05$), but there was no significant relationship between the value of body mass index and the severity of diabetic neuropathy. **Conclusion:** Increased HbA1c levels are associated with increased severity of peripheral neuropathy in patients with diabetes mellitus.

1. Introduction

Diabetes mellitus (DM) is a group of metabolic syndromes that is still a global health problem.[1,2] Over the last decades, the overall prevalence of diabetes mellitus has increased dramatically, mainly as a result of the prolonged increase in the incidence of type 2 diabetes mellitus. Its prevalence is rapidly becoming an epidemic in several countries around the world.[3,4,5] An increase in the prevalence of diabetes mellitus will directly lead to an increase in the prevalence of complications caused by diabetes itself.[2] Diabetic neuropathy is one of the earliest and most common diabetic microvascular complications. The most common pathophysiology underlying the occurrence of diabetic neuropathy is the condition of chronic hyperglycemia and microangiopathy that occurs in patients with diabetes mellitus.[2,6]

Diabetic neuropathy has the main symptoms of symmetrical paresthesias and burning pain, which generally occurs in the distal extremities. Patients with severe diabetic neuropathy are also at risk of ulceration of the distal extremity, which can lead to non-traumatic amputation.[7] Therefore, periodic evaluation of the progression and severity of diabetic neuropathy is needed in order to prevent or slow down

further complications of diabetic neuropathy. The severity of diabetic neuropathy can be evaluated through electrophysiological examination. On electrophysiological examination, nerve conduction studies are the gold standard in the diagnosis and evaluation of the progression of diabetic neuropathy with peripheral nerve dysfunction.[8,9,2,10] Several studies have reported that the degree of severity of electrophysiological features in DM patients may be associated with poor glycemic control. Glycemic control in DM patients can be evaluated through a rate check of glycosylated hemoglobin or HbA1c. This test is a glycemic control monitoring test that provides information about the degree of blood glucose control in the previous 2-3 months. Furthermore, high levels of HbA1c are known to be one of the important predictive risk factors that risk DM complications in the future. Monitoring HbA1c levels below 6.5% is very important to reduce the incidence of DM complications.[7] In the recent literature, it is said that HbA1c level may be a factor that plays a role in the pathogenesis of diabetic foot complications and is an important factor in peripheral nerve axonal dysfunction.[11] Although there have been many studies assessing the relationship between HbA1c levels and complications of DM, there are still few studies or consensus assessing the variability of HbA1c levels in diabetic peripheral polyneuropathy.[12,13,14] This study aimed to assess and determine the relationship between Body Mass Index and HbA1c with the severity of diabetic neuropathy.

2. Methods

This study is an analytic observational research approach cross-sectional, where the study population was all patients with diabetes mellitus (DM) who went to the neurology polyclinic at Dr. M Djamil General Hospital, Padang, Indonesia. Samples are taken with the method of consecutive sampling on subjects who meet the inclusion criteria and exclusion. The inclusion criteria were patients who had been diagnosed suffering from diabetes mellitus based on medical record data, aged 35-70 years and were willing to participate in this study. While patients with other comorbidities that can cause peripheral neuropathy and patients who are taking drugs that have the potential to cause peripheral neuropathy were excluded from this study. This study was approved by the medical and health research ethics committee at Dr. M Djamil General Hospital, Padang, Indonesia.

There were 25 research subjects, where in the early stages, data were recorded on the basic and clinical characteristics of the subjects, such as age, sex, body mass index, and HbA1c levels. A nerve conduction velocity examination was performed on all subjects to determine the severity of diabetic neuropathy. The severity of diabetic neuropathy is classified according to Baba's diabetic neuropathy classification (BDC) to 5 degrees, namely degrees 0 to 4. Data analysis was carried out using SPSS 25.0 for Windows. Analysis of the relationship between categorical variables was carried out by testing chi-square and analysis of the relationship between HbA1c levels and the severity of diabetic neuropathy using one-way ANOVA test. Results are considered statistically significant when the p-value is < 0.05.

3. Results and Discussion

Table 1 shows that 52% are women, with an average age of 57.88 ± 8.9 years. Body mass index is classified into 4 groups, namely, underweight (4%), normal (28%), overweight (12%), and obese (56%). Classification of the severity of diabetic neuropathy based on electrophysiological examination is grouped into 5 groups, namely, BDC 0 (normal), 1 (mild), 2 (moderate), 3 (moderate-severe), and 4 (severe). On examination of HbA1c levels, the average level was 8.9 ± 2.2.

Table 1. Basic characteristics.

Characteristics	Frequency
Age, mean (±SD)	57,88 (± 8,92)
Median (Min-max)	56,00 (36-69)
Gender, n(%)	
Male	12 (48%)
Female	13 (52%)
Severity of DPN	
Normal	5 (20 %)
Mild	5 (20 %)
Moderate	5 (20 %)
Moderate-severe	5 (20 %)
Severe	5 (20 %)
HbA1c levels, Mean (±SD)	8,9560 (± 2,22)
Median (Min-max)	8,2000 (5,90-14,00)
Body mass index	
Underweight	1 (4%)
Normal	7 (28 %)
Overweight	3 (12%)
Obese	14 (56%)

Bivariate analysis was carried out to find a relationship between HbA1c levels and body mass index with the severity of diabetic neuropathy. In this study, a significant relationship was found between HbA1c levels and the severity of diabetic neuropathy (p=0.000). There was no significant relationship between the value of body mass index and the severity of diabetic neuropathy (p=0.888).

Table 2. Relationship between HbA1c levels and the severity of diabetic neuropathy.

		n	HbA1c levels Mean(SD) mg/dl	p*
The severity of neuropathy diabetic	Normal	5	7,14 (0,84)	0,000
	Mild	5	7,28 (0,29)	
	Moderate	5	8,56 (1,30)	
	Moderate-severe	5	9,94 (2,47)	
	Severe	5	11,86 (1,14)	

*One-way ANOVA test, p<0.05.

Table 3. The relationship between BMI and the severity of diabetic neuropathy.

		The severity of diabetic neuropathy					
		Normal n (%)	Mild n (%)	Moderate n (%)	Moderate -severe n (%)	Severe n (%)	P* n (%)
BMI category	Underweight	0 (0)	0 (0)	0 (0)	0 (0)	1 (100)	0,888
	Normal	2 (28,6)	2 (28,6)	1 (14,3)	1 (14,3)	1 (14,3)	
	Overweight	0 (0)	0 (0)	2(66,7)	1 (33,3)	0 (0)	
	Obese	3 (21,4)	3 (21,4)	2 (14,3)	3 (21,4)	3 (21,4)	
Total		5 (20)	5 (20)	5 (20)	5 (20)	5 (20)	

*Chi-square test, p<0.05.

These results are in accordance with several previous studies, where it was found that the degree of hyperglycemia illustrates the severity of polyneuropathy and increases the risk of polyneuropathy in DM patients by 5 times. Other studies have also shown a significant relationship between HbA1c levels and the severity of diabetic neuropathy. Other research also showed that complications from diabetes mellitus, such as neuropathy, retinopathy, and nephropathy, occurred

in diabetes mellitus patients with HbA1c levels of 8.5. Increasing HbA1c levels will further accelerate and exacerbate neuropathy complications.[15-19]

Meanwhile, the relationship between body mass index and the severity of diabetic neuropathy in this study was found to have no significant relationship. These results are consistent with studies that state that there is no significant relationship. This may be related to the finding that patients with a low or high body mass index are found to suffer from diabetic neuropathy.[15] These results are different from other studies, where body mass index has an independent relationship with the incidence of neuropathy. Other studies have also found that there is a relationship between obesity and the incidence of diabetic neuropathy, although, in that study, further findings were found which showed that body fat index and waist circumference were more accurate indicators of the relationship between obesity and neuropathy when compared to BMI.[20-24]

4. Conclusion

There was a significant relationship between HbA1c levels and the severity of diabetic neuropathy. However, no significant relationship was found between body mass index and the severity of diabetic neuropathy.

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