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Predicting Sociodemographic Factors with Diabetic Peripheral Neuropathy in Type 2 Diabetes Mellitus Patients

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Abstract:
Background*: Diabetic peripheral neuropathy is one of the most common chronic complications in patients with type 2 diabetes mellitus and can significantly reduce quality of life. The increasing number of diabetes cases, both globally and nationally, has also increased the prevalence of diabetic peripheral neuropathy. The purpose of this study was to determine the relationship between sociodemographic and the incidence of diabetic peripheral neuropathy in patients with type 2 diabetes mellitus*
Materials and Methods*: This study used a cross-sectional design. The sampling technique with Cohen's formula obtained 68 respondents. Data collection used the Michigan Diabetic Neuropathy Score. Data analysis was performed with descriptive statistics, chi-square test, and binary logistic regression.*
Results*: The majority of respondents were in the late elderly category (56–65 years), had suffered from diabetes for more than 10 years, and had uncontrolled HbA1c levels. Bivariate analysis showed a significant relationship between age (p = 0.014), duration of diabetes (p = 0.024), and HbA1c levels (p = 0.001) with the incidence of diabetic peripheral neuropathy. Multivariate analysis showed that HbA1c levels were the most dominant factor influencing diabetic peripheral neuropathy, with an odds ratio (OR) of 16.357, which means that respondents with high HbA1c levels were 16 times more at risk of experiencing diabetic peripheral neuropathy than patients with normal HbA1c levels.*
Conclusion: *There is a significant relationship between sociodemographic characteristics, especially age, duration of diabetes, and HbA1c levels with the incidence of diabetic peripheral neuropathy in T2DM patients. Among the three factors, uncontrolled HbA1c levels are the most influential determinant. Efforts to control HbA1c are very important in the prevention and management of diabetic peripheral neuropathy.*
Keywords*: Diabetic; Neuropathy; Sociodemographic; HbA1c*

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I. Introduction

Diabetes Mellitus Type 2 is a chronic metabolic disease characterized by hyperglycemia due to impaired insulin secretion, insulin resistance, or both. One of the most frequent long-term complications that impacts the quality of life of sufferers is diabetic peripheral neuropathy, which occurs in about 50% of DMT2 patients(1).

Diabetic peripheral neuropathy is a form of neuropathy that attacks the peripheral nerves, especially in the lower extremities, and is characterized by symptoms such as pain, burning, tingling, and loss of sensation. This complication not only reduces the patient's motor and sensory function, but also increases the risk of diabetic foot ulcers and amputation if not treated properly(2). Globally, an estimated 537 million adults aged 20 to 79 years, representing 10.5% of individuals in this age range, have diabetes. Projections indicate an increase to 643 million people with diabetes by 2030, and a further increase to 784 million by 2045. In recent decades, type 2 diabetes mellitus has become a serious threat to human health(3).

In Southeast Asia, patients with type 2 DM number around 90 million people. This number is estimated to reach 113 million people in 2030 and 151 million people in 2045. More than one in two adults living with type 2 DM are undiagnosed and as many as 747,000 deaths occurred in 2021(4).

According to data from the 2018 Basic Health Research Report, in Indonesia the number of type 2 DM sufferers is 1.1 million people according to age category. The province in Indonesia with the most Type 2 DM sufferers in 2018 was West Java (186 thousand people), while Aceh province is included in the top nine provinces

in Indonesia with the most people suffering from DM with an estimated 417,600 sufferers or 8.7% of the total population of Aceh[5].

The prevalence of DPN in patients with type 2 diabetes mellitus is quite high and increases with age, duration of diabetes, and poor glycemic control. Sociodemographic factors such as age play an important role, where the elderly are more susceptible to nerve damage due to physiological and degenerative changes[6]. Duration of diabetes is also a major determinant of DPN, because exposure to chronic hyperglycemia over a long period of time increases the accumulation of metabolic and vascular damage that impacts nerve function[7]. In addition, high HbA1c values reflect poor glycemic control and are closely associated with the risk and severity of peripheral neuropathy. HbA1c is an important indicator of long-term glycemic control[8].High HbA1c values indicate chronic hyperglycemia, which can trigger oxidative stress and endothelial damage, causing microcirculation disorders and ultimately resulting in nerve damage[9].

However, there are still variations in the results in various studies related to the strength of the relationship between these variables and diabetic peripheral neuropathy. This indicates the need for further research with a local context, especially in primary health facilities and referral hospitals in Indonesia. Based on the data above, researchers are interested in conducting research on the relationship between sociodemographic and the incidence of diabetic peripheral neuropathy in patients with type 2 diabetes mellitus.

II. Materials and Methods

This study was conducted on patients diagnosed with type 2 diabetes mellitus (T2DM) who were treated at the Endocrine Polyclinic of the Provincial Hospital, Banda Aceh, Indonesia from May 2023 - April 2024.

Study Design: This type of research is quantitative with a cross-sectional study design.
Study Location: Endocrine Polyclinic, Dr. Zainoel Abidin Regional Hospital, Banda Aceh.
Study Duration: May 2023 to April 2024.
Sample size:68 patients.
Sample size calculation: The number of samples in this study was calculated based on the sample calculation technique by Cohen (1988), at a confident interval of 95% alpha = 0.05, a sample of 68 respondents was obtained.
Subjects & selection method: The population of this study was all patients diagnosed with type 2 diabetes mellitus, during January-April 2024 as many as 800 respondents. However, the prediction of type 2 diabetes mellitus patients who experience diabetic peripheral neuropathy for a month is 100 respondents.

Inclusion criteria:
1. Patients ≥ 6 months since being diagnosed with type 2 DM.
2. Patients with blood pressure (90/60 – 160/110 mmHg)
3. The patient is able to communicate verbally with fully awareness.
4. Patients are willing to be respondents and sign informed consent when data collection.
5. The screening results showed diabetic peripheral neuropathy.
6. Using oral medication and/or insulin therapy.

Exclusion criteria:
1. Patients who experience visual impairment, hearing impairment, disabilities and mental disorders.
2. Patients who have dependency on care due to diseases other than type 2 DM.

Procedure methodology

This study obtained ethical approval from the Health Research Ethics Committee of dr. Zainoel Abidin Banda Aceh, with number 001/ETIK-RSUDZA/2025. The respondent provided written informed consent before data collection. The data collection process began with a structured interview using a validated questionnaire. The questionnaire contains sociodemographic information including age, duration of DM disease, and identification of HbA1c values. This data was obtained directly from patients with type 2 diabetes mellitus (DMT2) who underwent routine checks at the Endocrine Polyclinic of provincial hospital of Banda Aceh, Indonesia.

HbA1c level measurement was obtained from the last laboratory test results within three months of data collection. HbA1c levels were considered uncontrolled if ≥7.0%, according to the American Diabetes Association (ADA) guidelines. These results were verified from the hospital laboratory information system to ensure the validity of the data.

To assess the presence of peripheral neuropathy, a sensory examination using 10-gram monofilament was performed at standard points on the soles of the feet. The examination was performed by researchers and trained nurses, using procedures according to the WHO protocol. If the patient could not feel pressure at ≥4 of the 10 examination points, then the patient was categorized as having diabetic peripheral neuropathy and then measured using the Michigan Diabetic Neuropathy Score questionnaire.

Statistical analysis

Data were analyzed using computerized. Descriptive statistical tests, chi square and binary logistic regression with the stepwise method were conducted in this study.

III. Results

Based on data analysis, the research results were obtained as in Tables 1-4 as follows:

Table 1 showed the majority of respondents are elderly (56-65 years) as many as 35 respondents (51.5%). The majority of the duration of the disease > 10 years as many as 29 respondents (42.6%). The majority of HbA1c is uncontrolled as many as 56 respondents (82.4%) and the majority of diabetic peripheral neuropathy is moderate to severe as many as 56 respondents (82.4%).

Table 1: Distribution of age, duration of disease, and HbA1c with the incidence of diabetic peripheral neuropathy (n=68)

No	Variables	f	%
1	Age (years)		
	36-45	4	5.9
	46-55	15	22.1
	56-65	35	51.5
	>65	14	20.6
2	Duration of Illness		
	< 5 years	12	17.6
	6-10 year	27	39.7
	>10 years	29	42.6
3	HbA1c		
	Controlled	12	17.6
	Not controlled	56	82.4
4	Diabetic peripheral neuropathy		
	Controlled	18	26.5
	Not controlled	50	73.5

Table 2 showed there is a significant relationship between age (P = .014), duration of disease (P = .024), and HbA1c (P = .001) with diabetic peripheral neuropathy in patients with type 2 diabetes mellitus.

Table 2: Relationship of factors influencing diabetic peripheral neuropathy

Variables	Diabetic peripheral neuropathy				
	Light		Medium-heavy		*p*
	n	%	n	%	
Age (years)					0.014
36-45	3	75	1	25.9	
46-55	7	46.7	8	24	
56-65	6	17.1	29	24.8	
>65	2	14.3	12	85.7	
Duration of illness					0.024
<5 years	2	16.7	10	83.3	
6 – 10 years	12	44.4	15	55.6	
>10 years	4	13.8	25	86.2	
HbA1c					0.001
Controlled	8	66.7	4	33.3	

Not controlled	10	17.9	46	82.1	

Table 3 showed age and HbA1c eligibility obtained significant values <0.25, so it can be concluded that they are worthy of being included in the logistic regression model.

Table 3: The feasibility test model of the sociodemographic data

No	Predictor	*p*
1	Age	0.006
2	Duration of Illness	0.353
3	HbA1c	0.002

Table 4 showed the results of the final multivariate modeling analysis, it is known that the most dominant determinant associated with diabetic peripheral neuropathy is HbA1c (p = 0.001) with an OR=16.357 or respondents with type 2 diabetes mellitus with high HbA1c levels have a 16 times greater chance of experiencing diabetic peripheral neuropathy compared to respondents with normal or controlled HbA1c levels.

Table 4: Step 1 analysis results for age and HbA1c

No	Predictor	B	OR	*p*	95% CI	
					Lower	Upper
1	Age	1,346	3,841	0.002	1,621	9,097
2	HbA1c	2,795	16,357	0.001	3,140	85,194

IV. Discussion

Neuropathy is one of the microvascular complications and is the most common in people with diabetes mellitus with a prevalence reaching 60-70%[10]. Diabetes mellitus sufferers whose blood glucose levels are uncontrolled are at risk of experiencing microvascular complications, one of which is progressive peripheral nerve damage which is clinically known as diabetic neuropathy[11]. Decreased pain perception in peripheral neuropathy can cause people with diabetes mellitus to experience diabetic ulcers[12]. Complications due to type 2 diabetes mellitus as a whole can increase hospitalization rates, death, and disability. If not controlled and not treated properly, type 2 diabetes mellitus will cause serious complications, such as increased blood clotting, retinopathy, hypertension, chronic kidney disease, or foot ulcers. It also significantly reduces the productivity and life expectancy of sufferers[13].

The results showed that of the three factors analyzed, age, duration of illness, and HbA1c levels, had a significant relationship with the incidence of diabetic peripheral neuropathy. The HbA1c variable was the most dominant factor influencing the incidence of diabetic peripheral neuropathy with an OR value of 16.357, a 16-fold greater chance of experiencing diabetic peripheral neuropathy. Although advanced age and duration of illness also showed a statistically significant relationship in bivariate analysis, both did not show as strong an influence as HbA1c when tested together in a logistic regression model. This confirms that chronic hyperglycemia, indicated by high HbA1c, is the most significant risk factor

Physiologically, aging causes degenerative changes in the peripheral nervous system, such as decreased number of Schwann cells, decreased axon regeneration, and impaired micro blood flow. Therefore, the elderly are more susceptible to nerve complications such as diabetic peripheral neuropathy. Several studies support that old age (≥ 60 years) is an important risk factor for neuropathy in diabetic patients[14].

Longer duration of diabetes mellitus was significantly associated with an increased risk of developing diabetic peripheral neuropathy. This is due to chronic exposure to hyperglycemia accelerating the process of nerve damage through mechanisms of oxidative stress, mitochondrial dysfunction, and accumulation of glycation end products (AGEs) that damage the structure and function of peripheral nerves[15]. A study found that every one-year increase in duration in patients with type 2 diabetes increased the likelihood of developing DPN by 10–15%. Longer disease duration provides more time for microvascular complications to develop, including damage to the small blood vessels that supply peripheral nerves[16].

The HbA1c factor serves to assess the average blood glucose levels over the past two to three months and is an important indicator in measuring glycemic control in patients with diabetes mellitus. Increased HbA1c levels are significantly associated with an increased risk of microvascular complications, including diabetic peripheral neuropathy[17]. Chronic hyperglycemia causes oxidative stress, activation of the polyol pathway, formation of advanced glycation end-products (AGEs) all of which have a direct impact on nerve damage[18].

HbA1c levels showed a closer correlation with decreased sensory and motor nerve function compared to age factors[19].

Patients with HbA1c > 8% have a 5.4 times higher risk of developing diabetic peripheral neuropathy compared to patients with HbA1c <7%[20]. A study showed that every 1% increase in HbA1c levels increased the risk of neuropathy by 23% after controlling for age and duration of diabetes[21]. Poor glycemic control is not only associated with the incidence of DPN, but is also correlated with the intensity of neuropathic pain and the resulting disability[22]. Thus, HbA1c is not only a diagnostic marker, but can also serve as a prognostic predictor for neuropathic complications in patients with type 2 diabetes mellitus.

This finding is also supported by data from this study, where the majority of patients with uncontrolled HbA1c experienced moderate to severe DPN, regardless of age category. This confirms that although age is a non-modifiable risk factor, HbA1c is a modifiable risk factor, making it a major target in efforts to prevent and manage DPN in patients with type 2 diabetes mellitus.

V. Conclusion

The results of the study proved that there was a significant relationship between sociodemographic; age, duration of disease and HbA1c with diabetic peripheral neuropathy in patients with type 2 diabetes mellitus. Sociodemographic characteristics of HbA1c are the most dominant variables influencing the incidence of diabetic peripheral neuropathy. Patients with uncontrolled HbA1c levels have a much greater chance of experiencing diabetic peripheral neuropathy compared to patients with controlled HbA1c.

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