

## The Relationship between Physical Activity and the Incidence of Diabetic Peripheral Neuropathy in Type II Diabetes Mellitus Patients at Maesan Public Health Center

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### ABSTRACT

**Background:** Diabetes Mellitus (DM) is a chronic disease characterized by blood glucose (blood sugar) levels exceeding normal. a complication of Type II DM is diabetic neuropathy. Diabetic neuropathy is damage caused by high blood sugar that injures nerves throughout the body. Management of diabetic neuropathy includes blood sugar control, pain treatment, and regular physical activity. Physical activity plays a role in reducing insulin resistance through various mechanisms. The purpose of this study was to determine the relationship between physical activity and the severity of diabetic peripheral neuropathy in type II DM patients at Maesan Health Center.

**Method:** This research design uses a correlation with a crosssectional approach, the sample size is 65 patients with type II diabetic peripheral neuropathy who are at the Maesan Health Center which is taken using consecutive sampling technique. The analysis used in this study was spearman rho with  $\alpha = 0.05$ .

**Result:** The results of this study were 28 respondents with high physical activity with the severity of diabetic peripheral neuropathy in the asymptomatic category and symptomatic severity of 7 respondents

**Conclusion:** The statistical test results obtained p value (0.000) so that H1 is accepted, which means that there is a significant relationship between physical activity and the severity of diabetic peripheral neuropathy in type II diabetes. The value of the correlation coefficient obtained a correlation coefficient of (-0.713) which means including a very strong relationship, with the relationship between the two variables being negative.

**Keywords:** *Type II DM; Physical activity; Diabetic peripheral neuropathy*

## Introduction

Diabetes Mellitus (DM) is a chronic disease characterized by blood glucose (blood sugar) levels exceeding normal. This disease is caused by metabolic disorders that occur in the pancreas, which is characterized by an increase in blood sugar or hyperglycemia. Diabetes has 2 types, namely type 1 diabetes mellitus which is the result of an autoimmune reaction to pancreatic islet cell proteins, then type II diabetes which is caused by a combination of genetic factors associated with impaired insulin secretion, insulin resistance and environmental factors, one of which is diabetic neuropathy (Sao Da et al., 2023).

Southeast Asia, where Indonesia is one of the countries, ranks 3rd with 11.3% of diabetes mellitus patients. Indonesia ranks 7th out of 10 with the highest number of patients with 10.7 million people. The prevalence of diabetes mellitus increased from 6.9% to 10.9% in the population aged  $\geq 15$  years (Widiasari et al., 2021). The incidence of neuropathy in DM patients is still high. The incidence of diabetic neuropathy in patients with diabetes mellitus is quite high, which is around 50% of the adult population with diabetes, both type 1 and type II (Sumardiyono & Suri, 2022). DM patients with neuropathy experienced mild neuropathy as much as 47.0%, moderate 24.2%, and severe 28.8%. Neuropathy in DM patients is highest at the age of 50-59, which is 52.7% of the age group 40 to  $>70$ . Female patients experienced a higher rate of neuropathy at 77.8% compared to men at 22.2% (Rahmi et al., 2022).

Neuropathy patients also still experience a lot of pain in the feet. Mild pain with electric shock 18.8%; moderate pain with numb feet 37.7%; moderate pain with deep pressure 25.0%, moderate pain with burning 6.3% (Novita, 2023). Based on RISKESDAS in 2018, the prevalence of people with T2DM in East Java is 2.6%, an increase compared to 2013 which was only 2.1% (Risksdas, 2018). In 2022 in Bondowoso Regency, there were 12,717 and the prevalence of diabetes cases in children increased 70 times in January 2023, at the Maesan Health Center there were 791 patients with diabetes mellitus (Bondowoso District Health Office, 2022).

A common complication of DM is diabetic neuropathy. It is estimated that half of people with DM experience neuropathy (Rahmi et al., 2022). Diabetic neuropathy is damage that occurs in people with diabetes due to high blood sugar that injures nerves

throughout the body. This condition most commonly occurs in the legs and feet, and can affect the digestive system, urinary tract, blood vessels, and heart. Diabetic neuropathy affects about 50% of people with diabetes, and can trigger various complaints such as foot deformities, infections, ulcers, reduced sensation, nerve damage, pain, and interference with various body functions such as temperature regulation, blood pressure, urination, and sexual response (Rachmantoko et al., 2021).

Diabetic neuropathy can occur in various nerve locations, such as the arms, hands, feet, soles of the feet, thighs, wrists, chest, back, muscles that control the eyes, and nerves in the heart and circulatory system. Diabetic neuropathy is caused by high blood sugar that damages nerves throughout the body, but the exact cause is not yet known (Sulistyoningtyas & Dwihestie, 2022).

DM management is called the pillars of DM management, namely Education, Meal Planning, Physical Exercise and Pharmacological Intervention (Merdawati, & Malini, 2019). There have been many advances in diabetes therapy in terms of treatment, but many patients find it difficult to maintain blood glucose levels within normal limits. Nurses play a role in lifestyle modification, blood glucose management, medication management and physical activity. Physical activity plays an important role in the prevention and management of type II DM. Physical activity is not only exercise but also daily activities. Blood glucose levels and normal body weight of people with diabetes mellitus can be maintained within normal limits through physical activity (Listiana et al., 2015).

Management of diabetic neuropathy includes blood sugar control, pain treatment, and regular foot care. In addition, regular physical activity and exercise can also help in improving the body's use of insulin and avoiding obesity, thus contributing to managing diabetic neuropathy. Some studies suggest that the severity of diabetic neuropathy may also be a risk factor for other complications, such as hard-to-heal foot wounds and amputation (Nurjannah et al., 2023).

Diabetic peripheral neuropathy requires a constant blood supply to function properly. Keeping the blood vessels healthy protects the nerves they supply, hence the need for regular exercise or physical activity to help the nervous system stay in top shape. Physical activity does not have to be strenuous. Physical activities that can be

done are cardiorespiratory exercises such as walking, cycling, jogging and swimming. Aerobic physical exercises such as walking, leisurely cycling, jogging, and swimming (Alpian & Alfarizi, 2022).

Research shows that regular physical activity, such as walking, can help control blood sugar levels and prevent diabetic complications, including diabetic neuropathy. In addition, lifestyle modification and regular exercise are also part of diabetes mellitus management to avoid complications such as diabetic neuropathy. Therefore, regular exercise can help reduce the risk of diabetic neuropathy in patients with type II diabetes mellitus (Karwati, 2022).

Physical activity can reduce insulin resistance through various mechanisms. When muscles contract, the membrane permeability to glucose increases, so the muscle takes up glucose from the blood more efficiently. The glucose void in the muscle causes the muscle to draw glucose from the blood, which reduces blood glucose levels. Regular physical activity can provide benefits for people with type II diabetes mellitus, including in reducing the risk of diabetic neuropathy. In physical activity there will be an increase in blood flow, causing more capillary nets to open so that more insulin receptors are available and receptors become more active and can increase cell sensitivity to insulin (Wanjaya et al., 2020).

Based on data from the Bondowoso City Health Office, in 2022 the highest incidence of diabetes mellitus was in Maesan Health Center with 791 cases of diabetes. Based on preliminary studies at the Maesan Health Center conducted by interviewing nurses, it is known that out of 5 people with diabetes mellitus, 3 patients have complaints of pain when doing activities, weakness when walking and often experience numbness or tingling in the feet, patients also often wake up if their feet feel numb or painful during sleep and to overcome this is by standing up. While 2 patients did not experience neuropathy.

Based on the results of the preliminary study above, it is necessary to conduct research on the relationship between physical activity and the incidence of diabetic peripheral neuropathy in type II DM patients at the Maesan Health Center.

## Method

This research design uses a correlation with a crosssectional approach, the sample size is 65 patients with type II diabetic peripheral neuropathy who are at the Maesan Health Center which is taken using consecutive sampling technique. The analysis used in this study was spearman rho with  $\alpha = 0.05$ . instruments in the research use the International Physical Activity Questionnaire and Neuropathy Symptom Score ethical approval. This research has received permission from the ethical commission of the Faculty of Health Sciences, Muhammadiyah University of Jember with ethical number No. 0194/KEPK/FIKES?XII/2024.

## Results

Research results must be clear and concise. If the research results are written in the form of tables or diagrams, there should be no overlap between the results shown in the tables/diagrams and the descriptions written in the text.

**Table 1.** Distribution of Respondents Based on Gender at Maesan Community Health Center, Bondowoso Regency July 2024 (n=65)

Gender	Frequency (n)	Percentage %
Male	32	49,2
Female	33	50,8
Total	65	100

The results of the distribution above showed that the gender of the respondents was mostly female, namely 33 respondents with a percentage (50.8%).

**Table 2.** Distribution of Respondents Based on Age at Maesan Community Health Center, Bondowoso Regency, July 2024 (n=65)

Age	Frequency (n)	Percentage %
40-45 Years	24	36,9
46-50 Years	22	33,8
51-55 Years	3	29,2
Total	65	100

The distribution results above show that the largest age range of respondents is in the 40-45 year age range, namely 24 respondents with a percentage of (36.9%)

**Table 3.** Distribution of Respondents Based on Education at Maesan Community Health Center, Bondowoso Regency, July 2024 (n=65)

Education	Frequency (f)	Percentage %
Elementary School	16	24,6
Junior High School	18	27,7
Senior High School	15	23,1
Graduate	16	24,6

	Total	65	100
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The results of the distribution above show that the majority of respondents' education is in the vulnerable range of junior high school respondents, namely 18 respondents with a percentage of (27.7%)

**Table 4.** Frequency Distribution Based on Physical Activity of Type II DM Sufferers at Maesan Community Health Center, Bondowoso Regency, July 2024 (n=65)

Physical Activity	Frequency (f)	Percentage %
Not enough	7	10,8
Currently	26	40,0
Tall	32	49,2
Total	65	100

Based on the results of the descriptive analysis above, it shows that almost the majority of respondents have high physical activity, namely 32 respondents with a percentage of (49.2%).

**Table 5.** Frequency Distribution Based on the Incidence of Diabetic Peripheral Neuropathy in Type II DM Patients at the Maesan Bondowoso Health Center in July 2024 (n=65)

Neuropathy	Frequency (f)	Percentage %
Asymptomatic Neuropathy	33	50,8
Symptomatic Neuropathy	24	36,9
Severe Polyneuropathy	8	12,3
Total	65	100

Based on the results of the descriptive analysis above, it shows that almost the majority of respondents have asymptomatic neuropathy, namely 33 respondents with a percentage of (50.8%).

**Table 6.** Analysis of the Relationship between Physical Activity and the Incidence of Diabetic Peripheral Neuropathy in Type II DM Patients at Maesan Health Center, Bondowoso Regency

Physical Activity	Severity of Diabetic Peripheral Neuropathy			Total	P	R
	Asymptomatic	Symptomatic	Severe polyneuropathy			
	Low	4	3			
Physical Activity	Medium	5	17	4	26	0,000 -0,713
	High	28	3	1	32	
	Total	33	24	8	65	

The cross tabulation results show a relationship between physical activity and the severity of diabetic peripheral neuropathy in type II DM at the Maesan Community Health Center. Low physical activity was found with the severity of Symptomatic diabetic peripheral neuropathy in 4 respondents and the severity of diabetic peripheral neuropathy Severe polyneuropathy in 3 respondents. Moderate physical activity with the severity of Asymptomatic diabetic peripheral neuropathy was 5 respondents, the severity of Symptomatic diabetic peripheral neuropathy was 17 and the severity of Diabetic peripheral neuropathy Severe Polyneuropathy was 4, while high physical activity with the severity of Asymptomatic diabetic peripheral neuropathy was 28 respondents and The severity of symptomatic diabetic peripheral neuropathy was 3 respondents. The results of the analysis using Rank Spearman rho between physical activity and the severity of diabetic peripheral neuropathy in type II DM obtained a value of ( $p = 0.000$ ) so that the  $p$  value  $\leq 0.05$ , which means that  $H_0$  is rejected and  $H_1$  is accepted, namely that there is a significant relationship between physical activity and severity of diabetic peripheral neuropathy in type II DM.

Meanwhile, the correlation coefficient value obtained is a correlation coefficient of -0.763 which means the level of strength of correlation/relationship is a very strong relationship. The correlation coefficient number is negative, which means that if physical activity is high, the severity of diabetic peripheral neuropathy in type II DM decreases.

## **Discussion**

### **Physical Activity in Patients with Type II DM at Maesan Health Center**

The results showed that physical activity at Maesan Health Center was in the high category. Physical activity is a body movement produced by skeletal muscles and requires energy. This activity refers to all movements including leisure time, transportation to go somewhere, or activities performed while working. Physical activity has an important role in diabetes management, as it is proven that regular physical activity can help prevent and manage non-communicable diseases, one of which is diabetes.

Based on its level, physical activity is divided into 3, namely light physical activity in the form of leisurely walking, doing household chores. Moderate physical activity can be in the form of fast walking (5 Km / hour), gardening, carpenter work, table tennis, badminton and soccer games. And heavy physical activity can be in the form of walking very fast > 5 km / hour, running, climbing mountains, jogging at a speed of 8 km / hour, basketball, volleyball, table tennis and soccer competitions (Putri, 2019).

Physical activity increases blood flow, causing more capillary channels to open, making insulin receptors more available and receptors more active. Exercise and weight loss can increase cell sensitivity to insulin. Physical activity has great benefits for one's health. Besides being beneficial for healthy people, physical activity also has important benefits for people suffering from DM. Healthy people or people suffering from DM are advised to do physical activity, but it needs to be emphasized for DM patients, there are several things that need to be considered before doing physical activity, one of which is blood sugar levels (Karwati, 2022).

This is in line with research conducted by Cilcilia (2019) The Relationship between Physical Activity and the Incidence of Diabetes Mellitus in Outpatients at the Bitung City Regional General Hospital. The relationship between physical activity and the incidence of diabetes mellitus is due to the relationship between the two. Physical activity is an activity that can be done by everyone. Everyone who does physical activity, the muscles will increase glucose burning to the maximum, and cause a decrease in blood sugar levels.

The researcher assumed that high physical activity has an impact on type II DM complications, because people are dynamic in carrying out their daily activities. The reason is that most people work as farmers and traders in the market. Despite the high physical activity carried out by people with type II DM, people with type II DM should also have a more possessive attitude to learn about diabetes mellitus and do physical activity regularly if the family supports and is enthusiastic about health education about diabetes mellitus. Regularity in doing physical exercise can control body weight, blood sugar levels, blood pressure, and most importantly can activate insulin production so that it works more efficiently. However, in patients with uncontrolled diabetes mellitus,

physical exercise can increase blood sugar levels and ketone bodies which can be fatal. The principles of physical exercise in diabetics include frequency, intensity, duration and type.

### **Incidence of Diabetic Peripheral Neuropathy in Type II DM Patients at Maesan Community Health Center**

Based on the results of the study, it shows that the severity of diabetic peripheral neuropathy in patients with type II DM at Maesan Health Center is in the asymptomatic (low) neuropathy category. The main factor affecting the severity of diabetic neuropathy in type 2 DM is high blood glucose. High blood glucose which results in fructose and accumulation of sorbitol and fructose in the nerves, resulting in the accumulation of sorbitol and fructose in the nerves and damaging the nerves.

Peripheral neuropathy often affects the distal part of nerve fibers, especially lower extremity nerves. It usually occurs first in the feet and legs than in the hands and arms. Symptoms of peripheral neuropathy include, Numbness or insensitivity to pain or temperature, Feeling of tingling, burning, or prickling, Sharp or cramping pain, Too sensitive to pressure even light pressure, Loss of balance and coordination. These symptoms are often worse at night. The severity of diabetic peripheral neuropathy is classified into 3 namely, asymptomatic neuropathy (low), symptomatic neuropathy (moderate), and symptomatic neuropathy (high). The development of peripheral neuropathy is influenced by the blood glucose control of DM patients. The worse the glucose control, the greater the risk of developing severe neuropathy (Suyanto, 2019).

This is in line with research conducted by Nurjannah (2023) with the research title Overview of the severity of peripheral neuropathy in patients with type 2 diabetes mellitus. Based on categorization data analysis, it was found that the majority of respondents had a severe degree of peripheral neuropathy with 23 people (50.0%), 21 people (45.7%) in the moderate category, 2 people (4.3%) in the mild category. The presence of insulin resistance and saturated free fatty acids causes changes in the fatty acid composition of plasma phospholipid membranes. Membranes rich in saturated free fatty acids become more rigid and show impaired electrical conduction and reduced

capacity for receptor expression and signal transduction, thus exacerbating peripheral neuropathy.

Researchers assume that there is significant variation in the severity of diabetic peripheral neuropathy among patients, ranging from mild to severe symptoms, depending on various factors such as diabetes duration, glucose control and lifestyle. Sensory symptoms, such as numbness, tingling, and pain, will be more dominant than motor symptoms. This is because the long sensory nerve fibers are more susceptible to damage from chronic hyperglycemia, so sensory symptoms appear more frequently and are more severe whereas motor symptoms usually occur in the more advanced stages of neuropathy and are not as common as sensory symptoms in the early stages.

### **The Relationship between Physical Activity and the Incidence of Diabetic Peripheral Neuropathy in Type II DM Patients at Maesan Health Center**

The results of this study showed that most respondents had high physical activity in managing the severity of diabetic peripheral neuropathy. This study identified a very strong correlation between physical activity and the severity of diabetic peripheral neuropathy. Good physical activity will determine the severity of diabetic peripheral neuropathy.

Diabetic neuropathy is a common complication associated with diabetes mellitus (DM) due to high blood sugar and high fat levels that can damage peripheral nerves. The most common type of diabetic neuropathy is peripheral diabetic neuropathy (NDP) which affects 25-50% of diabetic patients. In addition, it can result in side effects such as infections, foot blisters, and ulcers. Diabetic neuropathy is classified into acute and chronic neuropathy. The acute form is associated with severe weight loss and can cause severe pain with or without sensory loss. In acute type of diabetic neuropathy, there are no motor signs, loss of reflexes, or nerve degeneration. With adequate control, the disease will disappear completely within six months (Kosarian et al., 2022).

Chronic diabetic neuropathy causes inflammation and demyelination of nerves. It is characterized by sensory loss of stocking and glove distribution in the feet and legs, followed by the hands and arms. Signs and symptoms of chronic diabetic peripheral neuropathy include numbness, temperature changes, tingling or burning sensations,

muscle weakness, excessive sensitivity to touch, and mild gait abnormalities. You and these symptoms worsen at night. Insulin resistance has been known to play an important role in the development of peripheral neuropathy along with metabolic syndrome. Previous studies have reported that physical activity improves diabetes in general and prevents complications, such as PDN, by improving insulin sensitivity and increasing glucose uptake by cells. In addition, physical activity improves muscle and nerve structure and function renewing small sensory nerve damage. Physical activity can prevent DN through various mechanisms, including maintaining healthy blood glucose levels, increasing neuronal blood flow, promoting axonal renewal, increasing neurotransmitter concentrations, and Na/K-ATPase, which plays an important role in nerve conduction velocity (AlKhotani et al., 2023).

This is in line with research conducted by AlKhotani (2023) on the Relationship Between Physical Activity and Peripheral Neuropathy in Diabetes Patients: A Cross-Sectional Multicenter Study From Saudi Arabia which revealed that the severity of neuropathy decreased significantly when the level of physical activity increased ( $p = 0.039$ ). Muscle contraction increases blood glucose intake during exercise to promote intramuscular glycogenolysis. Resting muscles absorb glucose postprandially, depending on its level in the blood, to replace glycogen stores. Both routes increase glucose uptake by muscle after exercise.

Researchers assume that the main cause of neuropathy severity is uncontrolled glucose and therefore physical activity contributes to managing diabetic neuropathy. Physical activity can reduce insulin resistance through various mechanisms. When muscles contract, the membrane permeability to glucose increases, so the muscle takes up glucose from the blood more efficiently. The glucose void in the muscle causes the muscle to draw glucose from the blood, which reduces blood glucose levels.

## Conclusion

The distribution of respondents based on the level of physical activity was 32 respondents (49.2%) were at a high activity level. 26 respondents (40.0%) were at a moderate activity level, and only a small proportion of respondents (10.8%) were at a low activity level, namely 7 respondents. The distribution of the diabetic status of

peripheral neuropathy of respondents showed that most of the respondents, namely 33 respondents (50.8%) were at the Asymptomatic Neuropathy level and as many as 24 respondents (36.9%) were at Symptomatic Neuropathy, and a small proportion of respondents (12.3%) were in severe Polyneuropathy, namely as many as 8. There is a relationship between physical activity and the severity of Diabetic Peripheral Neuropathy in Type II DM Patients at the Maesan Health Center with a p value of 0.000. This research has several limitations, namely: This study may have respondent bias because it only involves respondents who are willing to participate, who may have uncontrolled physical activity. The questionnaire is difficult for respondents to understand and only the researcher understands it. The data collected relies on respondents' self-report, which could be influenced by their memory and subjectivity. This study may not fully cover all factors that influence physical activity and the severity of diabetic peripheral neuropathy, such as dietary variables that may not be measured. generalization of these findings to a wider population may be limited because this study was only conducted at the Maesan health center.

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