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The Relationship Between Body Mass Index and Foot Oxygen Saturation with Peripheral Neuropathy in Patients with Diabetes Mellitus

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ABSTRACT

Purpose: This study aims to analyze the relationship between body mass index (BMI) and foot oxygen saturation with the incidence of peripheral neuropathy in patients with diabetes mellitus, considering that this complication is common and can be influenced by various risk factors.
Research Method: This quantitative study used a cross-sectional design at the Gribig Kudus Community Health Center. A sample of 82 respondents was selected from 103 patients with diabetes mellitus using the Slovin formula and a purposive sampling technique, based on inclusion and exclusion criteria. The instruments included the Semmes-Weinstein Monofilament Test for diagnosing peripheral neuropathy, a scale and stature meter for measuring BMI, and a pulse oximeter for measuring oxygen saturation in the feet. Univariate analysis was conducted to describe the characteristics, and bivariate analysis was performed using the Spearman rank correlation test.
Results and Discussion: The results of the study indicate a relationship between BMI and foot oxygen saturation with the incidence of peripheral neuropathy in patients with diabetes mellitus. A high BMI and decreased oxygen saturation in the feet contribute to an increased risk of peripheral neuropathy through mechanisms involving circulatory disorders and microvascular damage.
Implications: These findings can serve as a basis for healthcare professionals to implement preventive interventions and early management of peripheral neuropathy complications through weight control, monitoring of extremity oxygen saturation, and education for patients with diabetes mellitus.

Keywords: diabetes mellitus; peripheral neuropathy; body mass index; oxygen saturation in the feet.

Introduction

Diabetes mellitus is one of the chronic diseases that has become a global health problem with a prevalence that continues to increase every year. Approximately 422 million people worldwide have diabetes, the majority of whom come from low- and middle-income countries, with 1.5 million deaths each year caused directly by diabetes (WHO, 2023). The latest data from the International Diabetes Federation (IDF) in 2021 shows that 537 million adults (aged 20–79) live with diabetes, and this number

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is projected to rise to 643 million by 2030 and 783 million by 2045. Every 5 seconds, one person dies from diabetes, resulting in a total of 6.7 million deaths in 2021 (IDF Diabetes Atlas, 2021). In Indonesia, the IDF reports that 19,465,100 adults aged 20–79 have diabetes, with a prevalence of 10.6% or approximately 1 in 9 people (IDF Diabetes Atlas, 2021). As of 2021, the Central Java Province reported 618,546 people with diabetes, with 91.5% of them receiving healthcare services by standards (Central Java Provincial Health Department, 2021). At a more local level, data from Kudus Regency in 2023 recorded 17,440 diabetes patients, with 1,251 patients in the Gribig Health Center area (Kudus Regency Health Department, 2023). One of the most common chronic complications found in diabetes patients is peripheral neuropathy, which is the leading cause of ulcers and lower extremity amputations (Bachri *et al.,* 2022). This condition highlights the urgent need to identify factors influencing peripheral neuropathy in diabetes patients, particularly in areas with high diabetes prevalence.

Various studies have examined the prevalence and risk factors of diabetic peripheral neuropathy in different countries. A systematic review and meta-analysis involving 23 studies with 269,691 participants showed a prevalence of peripheral neuropathy of 46%, with the highest prevalence in West Africa at 49.4% (Shiferaw *et al.*, 2020). In China, out of 14,908 patients with type 2 diabetes, 67.6% had diabetic peripheral neuropathy (DPN), with severity distribution of 47.7% mild, 33% moderate, and 19.3% severe (Wang *et al.,* 2023). Meanwhile, another study using the Neuropathy Symptom Score (NSS) and Neuropathy Deficit Score (NDS) in 985 patients with type 1 and type 2 diabetes showed a prevalence of DPN of 40.3% (Pfannkuche *et al.,* 2020). Several risk factors significantly influence the severity of neuropathy in diabetic patients, including age, duration of diabetes, HbA1c, vitamin D deficiency, body mass index (BMI), lipid levels, and carotid artery plaque (Putri *et al.,* 2020). Specifically, in various studies, BMI indicates that obesity is closely associated with the manifestation of neuropathy symptoms. High BMI triggers insulin resistance, leading to hyperglycemia and ultimately peripheral nerve damage (Aroor *et al.,* 2018). A study found that 69.1% of 178 overweight respondents experienced severe neuropathy symptoms (57.3%) (Kadri & Nurfitriani, 2021). Pfannkuche *et al.,* (2020) found a significant association between obesity (BMI ≥30) and the occurrence of DPN, with a prevalence of 50% in individuals with type 2 diabetes and 21% in those with type 1 diabetes. On the other hand, low peripheral oxygen saturation is also associated with microvascular complications, including neuropathy. Laursen *et al.,* (2023) concluded that SpO2 below 96% in type 1 DM patients is associated with an increased risk of albuminuria, retinopathy, and neuropathy. Meanwhile, increased blood circulation through physical activities, such as ROM exercises, has been proven to improve leg vascularity significantly (Sukarmin & Syafik, 2018).

Several studies have examined the prevalence and risk factors of peripheral neuropathy in patients with diabetes mellitus. However, there remain gaps, both theoretical and empirical, that have not yet been fully addressed. For example, the studies by Shiferaw *et al.,* (2020) and Wang *et al.,* (2023) focused more on the prevalence of DPN at the national and regional levels with a large population sample. Still, they did not specifically explain how physiological indicators such as body mass index (BMI) and foot oxygen saturation act as direct predictive factors for peripheral neuropathy, particularly at the primary healthcare level. Meanwhile, Putri *et al.,* (2020) identified various risk factors, including BMI, but did not include oxygen saturation as a key variable in their analysis. This is significant, given that Laursen *et al.,* (2023) found that SpO_2 levels below 96% are strongly associated with increased microvascular complications, including neuropathy. However, this study only included patients with type 1 diabetes and did not explore geographical contexts or primary healthcare facilities, such as community health centers. Additionally, few studies have integrated objective measurements of IMT and foot

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oxygen saturation simultaneously within a single analytical model, particularly in a local context such as the Kudus District. However, Sukarja & Sukawana (2020) and Sukarmin & Syafik (2018) demonstrated that reduced peripheral circulation and increased vascularity due to physical exercise can affect peripheral nerve conditions. Therefore, the relationship between IMT, oxygen saturation, and peripheral neuropathy still requires further empirical and contextual investigation.

The novelty of this study lies in the integration of two physiological indicators, namely Body Mass Index (BMI) and foot oxygen saturation, within a single analytical framework to examine their association with the occurrence of peripheral neuropathy in diabetes mellitus patients at the primary care level, specifically in the service area of the UPTD Puskesmas Gribig Kudus. Unlike previous studies that tended to discuss risk factors separately or only in the context of large populations and hospitals (Shiferaw *et al.,* 2020; Wang *et al.,* 2023; Putri *et al.,* 2020), this study specifically focuses on a community-based approach and addresses the gap in empirical studies evaluating IMT and oxygen saturation simultaneously about neuropathic conditions. Using a quantitative research method, this study aims to objectively determine and analyze whether there is a significant association between IMT and foot oxygen saturation, as well as the occurrence of peripheral neuropathy, in patients with diabetes mellitus. The results of this study are expected to provide both scientific and practical contributions, particularly in supporting efforts for early detection, preventing complications, and developing evidence-based interventions relevant to the needs of primary healthcare services in the Kudus region and its surroundings.

Literature Review and Hypothesis Development

Diabetes Melitus

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia, which is an elevated blood glucose level, resulting from insufficient insulin production, insulin resistance, or both. This disease has become a significant challenge in global healthcare systems due to its steadily increasing prevalence and the potential for long-term complications it causes. Zúnica-García *et al.,* (2024) state that type 2 diabetes dominates the majority of adult diabetes cases and is closely associated with an unhealthy lifestyle, high-calorie diets, and insufficient physical activity. The impact of DM on the body is multisystemic, with chronic complications that can affect both large (macrovascular) and small (microvascular) blood vessels, one of which is diabetic peripheral neuropathy (DPN). DPN is a disorder of the peripheral nervous system caused by metabolic and vascular damage triggered by chronic hyperglycemia, with symptoms ranging from pain, tingling, numbness, to loss of sensory function in the lower extremities. A recent study by Fadel *et al.,* (2024) confirms that the primary risk factors exacerbating DPN include a high body mass index (BMI), as obesity accelerates insulin resistance and triggers inflammatory reactions that damage nerve tissue. Meanwhile, Piccolo *et al.,* (2025) highlight the crucial role of the vascular system in the mechanism of DPN. Reduced peripheral blood flow leads to decreased oxygen supply to tissues, thereby worsening nerve condition through anaerobic metabolism and lactate accumulation.

Preventing complications of peripheral neuropathy in diabetes mellitus patients requires an integrated early detection strategy combined with promotive and preventive approaches. One method proven effective for initial screening is the Semmes-Weinstein Monofilament Test, a simple tool used to identify reduced sensation in the soles of patients' feet. Fadel *et al.,* (2024) noted that routine examinations using the monofilament test can significantly help identify patients in the early stages of

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neuropathy before the condition progresses to ulcers or amputation. In primary healthcare settings, this tool is highly ideal due to its low cost, practicality, and minimal training requirements. However, early detection must be followed by risk-based interventions that consider the patient's metabolic and vascular aspects. Eid *et al.,* (2023) emphasize the importance of comprehensive diabetes management, which includes weight control, meal planning based on a low-glycemic index diet, and regular physical activity. This aligns with an individualized and contextual approach to chronic disease management, particularly in community populations. In this context, physiological indicators such as BMI and foot oxygen saturation can be used as simple parameters to assess patients' risk status for peripheral neuropathy. Piccolo *et al.,* (2025) also demonstrated that evaluation of the peripheral vascular system has crucial diagnostic value, as reduced oxygen saturation in the feet is an early indicator of microcirculatory dysfunction that can accelerate nerve damage.

Neuropati Perifer

Peripheral neuropathy is a condition characterized by dysfunction of the peripheral nervous system, leading to sensory, motor, or autonomic impairments, typically caused by damage or dysfunction of peripheral nerve fibers. One of the most common forms of peripheral neuropathy is diabetic neuropathy, which is a chronic complication of diabetes mellitus. According to Yang *et al.,* (2025), diabetic peripheral neuropathy is not only caused by uncontrolled hyperglycemia but also involves complex pathophysiological mechanisms such as oxidative stress, systemic inflammation, accumulation of advanced glycation end products (AGEs), and impaired microcirculation leading to nerve ischemia. This degenerative process leads to the loss of myelin and axonal damage, ultimately impairing nerve impulse conduction. Clinical symptoms of peripheral neuropathy often begin with tingling sensations, burning pain, or even symmetrical numbness in the feet or hands. Over time, this condition can significantly reduce patients' quality of life, increase the risk of falls, and cause chronic wounds such as diabetic foot ulcers. Chang & Yang, (2023) emphasize the importance of early detection and holistic management of diabetic peripheral neuropathy, as its initial symptoms are often unnoticed by patients until nerve damage has progressed to an advanced stage. Their research suggests that a screening-based approach, utilizing simple tools such as the monofilament test and tuning fork, can aid in detecting sensory dysfunction at an early stage. These examinations should be part of routine evaluations for patients with diabetes, especially those with a disease duration of more than five years or poor glycemic control. Additionally, peripheral neuropathy can affect the autonomic nervous system, leading to complications such as orthostatic hypotension, digestive disorders, and bladder dysfunction.

In the management of peripheral neuropathy, a multidisciplinary approach is highly recommended to optimize clinical outcomes and slow the progression of nerve damage. Research by Lim *et al.,* (2022) shows that peripheral neuropathy is not limited to patients with diabetes mellitus but is also commonly found in individuals with obesity, even in the absence of hyperglycemia. These findings suggest that other metabolic factors, such as insulin resistance, subclinical inflammation, and elevated lipid levels, also contribute to the pathogenesis of neuropathy. Therefore, weight control, increased physical activity, and dietary management are essential components of preventive efforts. Orlando *et al.,* (2022) added that structured physical exercise tailored to the patient's capabilities plays a significant role in improving neuromuscular function. Exercises such as light aerobic exercise, strength training, and balance exercises not only help improve peripheral circulation but also stimulate nerve regeneration and enhance insulin sensitivity. On the other hand, Zhu *et al.,* (2024) outlined pharmacological and

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nonpharmacological treatment strategies for diabetic peripheral neuropathy. They explain that a combination of strict glycemic control, the use of neuroprotective agents such as alpha-lipoic acid, neurotrophic vitamins (B1, B6, B12), and antioxidant therapy can slow nerve damage and reduce symptoms. However, they also emphasize that the success of therapy heavily depends on patient involvement and treatment consistency. In addition to medical therapy, it is also crucial to educate patients about foot care, proper footwear, and the early detection of wounds to prevent amputations. Given the complexity of peripheral neuropathy, an intervention approach that focuses on only one aspect of therapy is insufficient. Integration between routine clinical examinations, healthy lifestyle interventions, and monitoring of metabolic parameters should be the primary strategy in healthcare practice, especially in primary care settings that manage a large and diverse population of diabetes patients.

Body Mass Index

The Body Mass Index (BMI) is an anthropometric measure used to assess an individual's nutritional status by calculating the ratio of body weight (in kilograms) to the square of body height (in meters). BMI has become one of the key indicators in assessing the risk of chronic diseases, including diabetes mellitus and its associated complications. Jia *et al.,* (2025) demonstrated, through a Mendelian randomization approach, that high BMI has a causal relationship with diabetic neuropathy, making it a risk factor that is not merely associative but also plays a direct role in the pathogenesis. Obesity, as indicated by high BMI, leads to metabolic disorders such as insulin resistance, elevated triglyceride levels, and chronic low-grade inflammation, which contribute to microvascular damage and peripheral nerve tissue damage. These findings are supported by Moosaie *et al.,* (2022), who found that obesity significantly increases the risk of diabetic complications, including retinopathy, nephropathy, and neuropathy, in both type 1 and type 2 diabetes. Additionally, the role of BMI as a risk indicator cannot be overlooked given the continuously rising global prevalence of obesity. Yang *et al.,* (2025) explain that excess adipose tissue triggers oxidative stress and produces pro-inflammatory molecules such as TNF-α and IL-6, which can damage endothelial cells and accelerate peripheral nerve damage. This process occurs gradually and often goes unnoticed by patients until clinical symptoms of neuropathy, such as tingling, pain, or numbness, appear. Therefore, regular monitoring of BMI is strongly recommended as an early detection measure for the risk of neurological complications, particularly in individuals with a history of diabetes or metabolic syndrome. In clinical practice, BMI measurement is easy to perform, cost-effective, and non-invasive, making it highly suitable for implementation at the primary healthcare level to identify patients effectively at high risk.

The importance of monitoring and intervening on BMI in diabetic patients is not limited to preventing macrovascular complications, but also plays a crucial role in slowing the progression of peripheral neuropathy. Tao *et al.,* (2025) state that diabetic patients with high BMI are more likely to experience painful diabetic neuropathy characterized by chronic pain, hypersensitivity, and sleep disturbances. They identified that visceral fat accumulation not only worsens insulin resistance but also contributes to neurotoxic hyperglycemia. Therefore, weight management strategies combining a healthy diet and structured physical activity are crucial to reduce the risk of diabetic neuropathy, even before clinical symptoms appear. In this context, educational programs emphasizing the importance of weight control and regular physical activity should be an integral part of diabetes care in the community. Meanwhile, research by Salinas *et al.,* (2022) highlights an interesting finding that impaired H-reflex (H-

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reflex) as an indicator of peripheral nerve function can be detected in individuals with high BMI, even though they have not been diagnosed with diabetes. This suggests that obesity may serve as a trigger for subclinical neuropathy before the onset of overt metabolic disorders. Thus, BMI can serve as an early indicator of risk for neurological dysfunction, making it highly relevant for screening high-risk populations. Integrating BMI measurements into primary healthcare services is a crucial step toward detecting potential neuropathy at a reversible stage. In the context of public health policy, efforts focused on weight management-based prevention have become increasingly urgent given the global trend of rising obesity rates and their associated complications.

Leg Oxygen Saturation

Foot oxygen saturation is a clinical indicator that reflects the level of oxygen saturation in the blood of the lower extremities, particularly the feet, measured using a pulse oximeter. This value indicates the extent to which oxygen carried by hemoglobin is available to peripheral tissues and is essential in assessing perfusion function in patients at risk of peripheral vascular disorders. In the context of diabetes mellitus, foot oxygen saturation has significant clinical implications because impaired microcirculation, commonly observed in diabetic patients, can hinder oxygen supply to peripheral tissues, trigger local hypoxia, and contribute to the development of peripheral neuropathy and chronic wounds. A study conducted by Siao *et al.,* (2018) demonstrated that pulse oximetry can be used as an efficient and non-invasive initial screening method for detecting peripheral artery disease (PAD) in patients with type 2 diabetes, with a sufficiently high sensitivity, even surpassing ankle-brachial index (ABI) measurements in certain conditions. Abián *et al.,* (2021) also confirmed that the use of pulse oximeters on the lower extremities can identify clinically unapparent perfusion disorders, particularly in asymptomatic diabetic patients. They demonstrated that decreased peripheral oxygen saturation correlates with abnormal ABI findings, indicating early vascular dysfunction. Similarly, Hiremath *et al.,* (2025) demonstrated that pulse oximetry showed a sensitivity of 84.6% and specificity of 73.9% in detecting PAD when compared to the standard duplex ultrasonography examination. This suggests that foot oxygen saturation not only reflects peripheral oxygenation status but may also serve as an early predictor of microvascular complications, including the risk of developing diabetic foot ulcers and peripheral neuropathy.

The importance of foot oxygen saturation in screening for peripheral neuropathy in diabetic patients is supported by studies investigating the relationship between peripheral hypoxia and nerve dysfunction. In a survey by Laursen *et al.,* (2021), it was found that patients with type 1 diabetes had lower blood oxygen saturation levels in the supine position compared to healthy individuals, indicating peripheral perfusion imbalance despite the absence of typical symptoms. This tissue hypoxia can worsen nerve cell metabolism and accelerate peripheral nerve damage. This finding is consistent with those of Hiremath *et al.,* (2025), who explained that in diabetic patients who have not yet clinically manifested symptoms of peripheral vascular disease, low oxygen saturation levels in the extremities can serve as an early indicator of circulatory dysfunction and an increased risk of neuropathy. One of the advantages of pulse oximetry is its ease of use, affordability, and minimal specialized skills required, making it highly suitable for primary healthcare settings. The use of pulse oximetry in screening practices has proven beneficial for detecting vascular disorders before they progress to advanced complications. Therefore, as part of promotive and preventive efforts against diabetes complications, including peripheral neuropathy, periodic foot oxygen saturation measurements should be included in routine procedures,

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especially for patients with long-standing diabetes or a high BMI. The combination of BMI measurement and foot oxygen saturation can provide comprehensive information on the risk of neurological and vascular complications. Monitoring foot oxygen saturation can serve as an effective and strategic tool for early detection, reducing the incidence of chronic complications in diabetic populations at both the community and clinical levels.

Research Method

This study employs a quantitative research design with a correlation analysis approach to investigate the relationship between two independent variables—Body Mass Index (BMI) and foot oxygen saturation—and the dependent variable, peripheral neuropathy, in patients with diabetes mellitus. The approach used in this study is a cross-sectional approach, where all variables are measured simultaneously at a specific point in time. This approach was chosen to obtain a direct and efficient overview of the relationship between variables without requiring long-term observation. The study was conducted in the working area of the Gribig Kudus Community Health Center (UPTD Puskesmas Gribig Kudus) in August 2024. The population in this study consisted of all patients with diabetes mellitus registered at the Gribig Kudus Community Health Center, totaling 103 individuals, as of August 2024. Sampling was conducted using purposive sampling, a technique that deliberately selects samples based on predetermined inclusion and exclusion criteria. This technique allows researchers to select respondents who are relevant and appropriate for the research needs. The sample size was determined using the Slovin formula with a 5% significance level, resulting in a sample size of 82 respondents. The inclusion criteria for this study were: (a) diabetes mellitus patients registered at the Gribig Community Health Center, (b) male and female, (c) aged 25–70 years, and (d) present during the data collection process.

The exclusion criteria were (a) patients with foot infections or open wounds that could affect the measurement results, and (b) patients who were unwilling to continue participating in the study after providing informed consent. Data were collected through direct measurement and observation using instruments that had been adapted to clinical examination standards. The Body Mass Index (BMI) was calculated by measuring body weight using a digital scale and height using a microtoise, then using the formula: BMI = body weight (kg) / (height in meters^{2} ^{2}. Foot oxygen saturation was measured using a pulse oximeter placed on the toe to determine peripheral oxygen levels. To assess the presence of peripheral neuropathy, a 10-gram monofilament was used at 10 points on the sole, in accordance with guidelines for neuropathy examination in diabetic patients. The examination was conducted by the researcher with the assistance of health center staff to ensure the accuracy of the results. The collected data were analyzed quantitatively using statistical software. Univariate analysis was used to describe the characteristics of the respondents, including the frequency distribution of BMI, foot oxygen saturation, and the occurrence of peripheral neuropathy. Furthermore, bivariate analysis was conducted to determine the relationship between independent variables (BMI and foot oxygen saturation) and the dependent variable (peripheral neuropathy), using the Chi-Square correlation test or alternative tests, such as the Fisher Exact Test, if the data did not meet the assumptions of the Chi-Square test. All results were analyzed at a significance level of 0.05 ($p < 0.05$) to determine the presence or absence of a significant relationship between the variables under study.

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Results and Discussion

Analysis Result

Based on Table 1, it can be seen that, out of a total of 82 respondents, the average age of patients with diabetes mellitus was 55.16 years. The median age was 55 years, indicating that half of the respondents were under that age and the other half were above it. Additionally, the most common age (mode) is also 55 years. The youngest respondent was 32 years old, while the oldest was 65. This data indicates that most diabetes mellitus patients in this study are in the middle-aged to early elderly age group, which is a vulnerable age group for metabolic disease complications such as diabetes mellitus. Meanwhile, the distribution of respondents by gender shows that the majority of patients with diabetes mellitus in this study are female, comprising 61 respondents, or 74.4%. The number of male respondents was 21, equivalent to 25.6% of the total.

Table 1. Characteristics of Respondents with Diabetes Mellitus at the Gribig Community Health Center

Variable	Subcategory / Statistics	Frequency (n)	Percentage (%)
Age (year)	Average (Mean)	55.16	-
	Median	55	-
	Modus	55	-
	Minimum	32	-
	Maksimum	65	-
Gender	Man	21	25.6
	Woman	61	74.4
	Total	**82**	**100.0**

Source: Primary Data 2025

Table 2. Frequency Distribution and Percentage of Body Mass Index (BMI), Foot Oxygen Saturation, and Monofilament Test Results in Patients with Diabetes Mellitus

Category	Subcategory	n	%
Body Mass Index	Underweight	8	9.8
	Normal	35	42.7
	Overweight	17	20.7
	Obesity 1	15	18.3
	Obesity 2	7	8.5
Leg Oxygen Saturation	Normal	77	93.9
	Low	5	6.1
Monofilament Test	Neuropathy	24	29.3
	High Risk	17	20.7
	Normal	41	50.0
Total		82	100.0

Source: Primary Data 2025

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Based on Table 2, it can be observed that the Body Mass Index (BMI) category exhibited a varied distribution among the 82 respondents. Respondents with a BMI in the underweight category numbered eight people, or 9.8% of the total respondents. Meanwhile, the majority of respondents fell within the normal BMI category, comprising 35 people, or 42.7%. Respondents with an overweight BMI were 17 people, or 20.7%. Additionally, 15 respondents (18.3%) were classified as obese, and seven respondents (8.5%) were classified as obese. This data indicates that more than half of the respondents had a BMI above the normal range, ranging from overweight to obese.

Based on the distribution of foot oxygen saturation, the majority of respondents showed conditions still within normal limits. A total of 77 respondents (93.9%) had normal foot oxygen saturation, while only five respondents (6.1%) showed low oxygen saturation. This finding suggests that most diabetes mellitus patients who participated in this study have not yet experienced significant peripheral oxygenation disorders. Meanwhile, the results of the Monofilament Test as an indicator of peripheral neuropathy showed that out of the total 82 respondents, 24 (29.3%) were diagnosed with peripheral neuropathy. Additionally, 17 respondents (20.7%) were classified as high-risk for neuropathy. The remaining 41 respondents (50%) showed normal monofilament test results.

Based on Table 3, the results showed that out of 82 respondents, those with a BMI indicating low body weight had 8 cases of monofilament test, with 1 case of neuropathy, 2 cases at high risk, and 5 cases with expected results. Respondents with a normal BMI had 35 cases, with 6 cases of neuropathy, 6 cases at high risk, and 23 cases with normal monofilament test results. Among respondents with an overweight BMI, 17 individuals underwent monofilament testing, with 7 cases of neuropathy, 5 cases at high risk, and five normal results. Among respondents with an obese BMI, 15 individuals underwent monofilament testing, with 6 cases of neuropathy, 3 cases at high risk, and six normal results. Respondents with obesity BMI 2 numbered 7, with monofilament test results showing 4 cases of neuropathy, 1 case at high risk, and 2 with normal monofilament test results.

Table 3. The Relationship Between Body Mass Index (BMI) and Peripheral Neuropathy in Patients with Diabetes Mellitus

Body Mass Index (BMI)	Monofilament Test						Total		P value	Correlation Coefficient
	Neuropathy		High Risk		Normal					
	N	%	N	%	N	%	N	%		
Underweight	1	12.5%	2	25.0%	5	62.5%	8	100%	0.004	-0.313
Normal	6	17.1%	6	17.1%	23	65.7%	35	100%		
Overweight	7	41.2%	5	29.4%	5	29.4%	17	100%		
Obesity 1	6	40.0%	3	20.0%	6	40.0%	15	100%		
Obesity 2	4	57.1%	1	14.3%	2	28.6%	7	100%		
Total	24	29.3%	17	20.7%	41	50.0%	82	100%		

Source: Primary Data 2025

Based on statistical test results, it was found that BMI has a significant relationship with the incidence of peripheral neuropathy in diabetes mellitus patients at the Gribig Kudus Community Health Center, with a p-value of 0.004<0.05, which means that there is a statistically significant relationship between body mass index and peripheral neuropathy in diabetes mellitus patients. Additionally, the correlation coefficient value of Spearman's rho was -0.313, indicating a weak negative relationship.

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Table 4. The Relationship Between Foot Oxygen Saturation and Peripheral Neuropathy in Patients with Diabetes Mellitus

Leg Oxygen Saturation	Monofilament Test						Total		P value	Correlation Coefficient
	Neuropathy		High Risk		Normal					
	N	%	N	%	N	%	N	%		
Normal	23	29.9%	16	20.8%	38	49.4%	77	100%		
Low	1	20%	1	20%	3	60%	5	100%	0.615	0.056
Total	24	29.3%	17	20.7%	41	50.0%	82	100%		

Source: Primary Data 2025

Based on Table 8, the results show that out of 82 respondents, 77 had normal foot oxygen saturation, 23 had neuropathy, 16 were at high risk, and 38 had normal monofilament test results. Among those with low oxygen saturation, five respondents had neuropathy, one was at high risk, and 3 had normal monofilament test results.

Based on the statistical test results, there was no significant association between foot oxygen saturation and peripheral neuropathy in diabetes mellitus patients at Gribig Kudus Health Center, with a p-value of 0.615 and a correlation coefficient of 0.056. A p-value greater than 0.05 indicates that the association is not statistically significant. Therefore, the overall results suggest that foot oxygen saturation does not have a meaningful association with peripheral neuropathy in diabetes mellitus patients at Gribig Kudus Health Center.

Discussion

Overview of Peripheral Neuropathy in Diabetes Mellitus Patients at the Gribig Kudus Community Health Center

Based on the frequency distribution data obtained in the monofilament test value category, it can be seen that out of 82 respondents with diabetes mellitus, 24 respondents (29.3%) had peripheral neuropathy with test results of 0–3 touch points, 17 respondents (20.7%) had a high risk of neuropathy with test results of 3.5–5 touch points, and 41 respondents (50%) had normal monofilament test results with test results of 5.5–8 touch points. The results of this study indicate a correlation between gender and age, with the average respondent being female (74.4%) and the average age of respondents in this study being 55 years, ranging from a minimum age of 32 years to a maximum age of 65 years. Women are more susceptible to diabetes mellitus and its complications, including diabetic peripheral neuropathy (DPN), compared to men due to hormonal and biological differences (Kautzky-Willer *et al.*, 2023). The decrease in estrogen levels after menopause is known to worsen vascular function and accelerate peripheral nerve damage in women with diabetes (Mubeen *et al.,* 2023). Studies also indicate that women with type 2 diabetes have a higher risk of painful DPN, even when glycemic control is similar to that of men (Kautzky-Willer *et al.*, 2023). Social factors also play a role, as women often prioritize family needs over their health, leading to delayed care-seeking, which increases the risk of complications such as DPN (Palomo-Osuna *et al.*, 2022). Another study in Europe found that women have a higher proportion of painful DPN development, with 73% of women experiencing painful DPN compared to 48% of men (p=0.003) (Elliott *et al.,* 2024). As people age, insulin sensitivity in the human body tends to decrease significantly, which is a significant factor contributing to impaired glucose tolerance. The increased risk of type 2 diabetes with age can be attributed to the age-related decline in intrinsic beta

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cell function (Mazzucato, 2020). A study conducted on 169 individuals, including 43 men and 126 women, showed that age was negatively correlated with insulin resistance and glucose effectiveness in both genders (IR: r = -0.39, p < 0.001 for men, r = -0.24, p < 0.003 for women; GE: r = 0.66, p < 0.001 for men, r = 0.78, p < 0.001 for women). At the same time, FPIS (first-phase insulin) was also found to be negatively correlated with age in women (r = -0.238, p = 0.003) (Huang *et al.*,, 2023). A study conducted on 32 participants found that age influences the ankle-brachial index (ABI) value, with an average age of 53.46 years (Yulisetyaningrum *et al.,* 2022).

Based on the study results, the most significant proportion of respondents with diabetes mellitus who experienced peripheral neuropathy were women with an average age of 55 years. This finding indicates a correlation between gender and age regarding the risk of diabetic peripheral neuropathy (DPN). This aligns with literature suggesting that women have a higher susceptibility to diabetes complications such as DPN, which may be attributed to hormonal factors, particularly the postmenopausal decline in estrogen levels that accelerates peripheral nerve damage. Additionally, advancing age has been proven to influence reduced insulin sensitivity and pancreatic beta cell function, thereby increasing the risk of developing diabetes and its complications, including DPN.

Body Mass Index Profile in Diabetes Mellitus Patients at Gribig Community Health Center

Based on statistical analysis of respondent distribution categorized by body mass index among diabetes patients at the Gribig Community Health Center, out of a total of 82 respondents, eight respondents (9.8%) had a BMI in the underweight category, 35 respondents (42.7%) had a normal BMI, respondents with overweight BMI were 17 respondents (20.7%), respondents with obesity level 1 were 15 respondents (18.3%), and respondents with obesity level 2 were seven respondents (8.5%). This indicates that most diabetes patients at Gribig Health Center have a BMI above the normal range. Diabetes mellitus is closely associated with obesity. Obesity reduces the response of pancreatic beta cells to increased blood glucose levels. Additionally, insulin receptors on cells throughout the body, including in muscles, decrease in number and become less sensitive. Obesity is associated with monotonous eating and lifestyle patterns. It is also influenced by physical activity, which can help control blood sugar levels. During physical activity, glucose is converted into energy, resulting in increased insulin production and lower blood sugar levels. An unhealthy diet, characterized by insufficient consumption of fruits and vegetables and a tendency toward overeating, can contribute to obesity (Putri *et al.*, 2022).

The Body Mass Index (BMI) is one of the anthropometric indicators used to assess an individual's nutritional status, based on the ratio of body weight to the square of body height. According to the World Health Organization (WHO), obesity, characterized by a high BMI, is a primary risk factor for the development of Type 2 Diabetes Mellitus (T2DM), as it is associated with insulin resistance and impaired glucose metabolism. A study using data from the Indonesia Family Life Survey (IFLS) showed that individuals with an obese BMI have a 3.29 times higher risk of developing DM compared to those with a normal BMI (Luthansa & Pramono, 2017). A similar study in Korea found that BMI has a significant association with the incidence of DM in middle-aged and elderly populations (Lee *et al.,* 2025). A study conducted on 79 participants titled "Factors Associated with Elevated Blood Sugar Levels in Diabetes Mellitus Patients at the Outpatient Unit of Dr. Loekmono Hadi Kudus General Hospital" showed a significant association between body weight and elevated blood sugar levels in diabetes mellitus patients with a p-value of 0.000 (Sukarmin *et al.,* 2020). However, a study in Palembang involving 33

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participants showed that BMI was not significantly associated with the occurrence of diabetes mellitus, with a p-value of 0.085. In contrast, waist circumference was more closely related to the risk of DM (Badri *et al.,* 2024). In Indonesia, the prevalence of obesity among diabetes mellitus patients is relatively high. A national study using a secondary data analysis design from the Basic Health Research (Riskesdas) 2018 found that 32.9% of individuals diagnosed with diabetes mellitus were obese. This study concluded that approximately one-third of individuals with diabetes in Indonesia are obese. Factors such as gender, age, history of hypertension, and lipid profile are closely associated with obesity prevalence among diabetes patients. These findings emphasize the importance of early detection and intervention in individuals with high BMI to prevent the development of DM (Azam *et al.,* 2023).

Based on the analysis of body mass index (BMI) distribution among diabetes mellitus patients at Gribig Health Center, it was found that the majority of respondents had a BMI above the normal range, categorized as either overweight or obese. These findings reinforce the hypothesis that excess body weight significantly contributes to the risk and progression of type 2 diabetes mellitus. A high BMI reflects excess body fat, which physiologically disrupts insulin function and triggers insulin resistance, thereby exacerbating hyperglycemia in patients. Additionally, sedentary lifestyles and unbalanced diets, such as low fiber intake from fruits and vegetables and high calorie intake, are factors that exacerbate this condition. However, it is worth noting that not all studies have found a significant association between BMI and diabetes. Nevertheless, BMI remains a valuable parameter for screening diabetes risk, particularly in populations with high obesity rates, such as those in Indonesia. Therefore, researchers suggest that early detection through BMI measurement, combined with nutritional intervention and increased physical activity, is an essential step in the prevention and management of diabetes mellitus at the primary healthcare level.

Overview of Oxygen Saturation in the Feet of Diabetes Mellitus Patients at the Gribig Community Health Center

Based on the analysis data, it can be determined that out of 82 respondents, 77 respondents (93.9%) had normal oxygen saturation in their feet, while five respondents (6.1%) had low oxygen saturation. This indicates that the average oxygen saturation level in the feet of diabetes mellitus patients in the Gribig Kudus Health Center area is within the normal range. Oxygen saturation levels are crucial to monitor, as they indicate the adequacy of oxygenation or tissue perfusion. A decrease in oxygen saturation can lead to impaired oxygen transport, as oxygen in the body is primarily bound to hemoglobin and dissolved in blood plasma (Setiawan *et al.,* 2024). Peripheral oxygen saturation in the feet of patients with diabetes mellitus (DM) is a crucial indicator for assessing blood circulation status and the risk of complications, such as diabetic foot ulcers. Decreased oxygen saturation may indicate impaired tissue perfusion due to microvascular damage commonly observed in DM (Mistphahie *et al.,*, 2024). Patients with diabetes mellitus have an increased risk of reduced blood circulation to peripheral areas, characterized by decreased oxygen saturation in these areas. If reduced circulation to the legs persists without effective intervention, it may impact cellular metabolism. Long-term metabolic decline indicates a shift toward anaerobic metabolism, producing lactic acid, which is associated with pain, numbness, and stiffness, and may progress to diabetic foot (Sukarja & Sukawana, 2020).

Diabetic patients are at risk of having lower SaO2 levels. A study conducted on 829 individuals with diabetes, 11,981 healthy controls, and 766 pre-diabetic subjects showed that the pre-diabetic and diabetic subgroups had lower SaO2 levels compared to non-diabetic individuals ($p < 0.01$) (Laursen *et*

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al.,, 2022). A study conducted on control subjects (without diabetes) and diabetic patients without neuropathy used Near-Infrared Spectroscopy (NIRS) to assess tissue oxygenation levels in the soles of diabetic patients. The results showed significant differences in tissue oxygenation index values across the three standard areas, with oxygenation levels in the foot area being significantly lower ($p < 0.05$) in the diabetic group compared to the control group. This study concluded that there is a decrease in tissue oxygenation in the soles of the feet of patients with diabetes mellitus (M. Brindha *et al.*,, 2021). However, another study showed that oxygen saturation in the feet of diabetes mellitus patients remained within normal ranges, as demonstrated in a study involving 17 patients with type 2 diabetes mellitus, where oxygen saturation in the feet before intervention showed normal values with an average of 95.12% and increased to 98.35% after intervention (Cahyani & Krisnanda, 2019).

The study results indicate that most respondents had normal oxygen saturation levels in their feet, despite the theoretical risk of peripheral perfusion disorders in patients with diabetes mellitus. This finding suggests that not all patients with diabetes mellitus experience an immediate decrease in oxygen saturation, possibly due to reasonable blood sugar control, adherence to therapy, and the absence of advanced complications. This finding aligns with previous studies that have also reported normal oxygen saturation levels in DM patients. Therefore, researchers conclude that monitoring oxygen saturation remains essential for the early detection of circulatory disorders. Normal values in most respondents are a positive indicator; however, further examinations are necessary to obtain a more comprehensive clinical picture.

The Relationship Between Body Mass Index (BMI) and Peripheral Neuropathy in Diabetes Mellitus Patients at Gribig Community Health Center

Based on the statistical analysis of respondent distribution categorized by body mass index (BMI) from a study involving 82 respondents, eight individuals with a low BMI were identified, with one case of neuropathy detected via the monofilament test, two cases at high risk, and five cases within the normal range. Respondents with normal BMI (35 individuals) showed the following results: 6 cases of neuropathy on the monofilament test, 6 cases at high risk, and 23 cases with normal monofilament test results. Respondents with an overweight BMI were 17 individuals, with monofilament test results showing 7 cases of neuropathy, five high-risk cases, and five normal monofilament test results. Respondents with an obese BMI were 15 individuals, with monofilament test results showing 6 cases of neuropathy, three high-risk cases, and six normal monofilament test results. Respondents with obesity BMI 2 numbered 7, with monofilament test results showing 4 cases of neuropathy, one at high risk, and 2 with normal monofilament test results. This indicates that the majority of respondents with peripheral neuropathy have a body mass index (BMI) above normal. Obesity causes a reduction in the number of insulin receptors that can function within skeletal muscle cells and fat tissue. This is due to peripheral insulin resistance. Obesity also impairs the ability of beta cells to release insulin in response to rising blood glucose levels (Kadri, 2021).

Individuals with excess body weight have an excessive calorie intake. Beta cells in the pancreas become overloaded and are unable to produce sufficient insulin to counteract the excess calorie intake. As a result, blood glucose levels rise, eventually leading to the development of diabetes mellitus (DM) (Sugiritama *et al.,* 2015). Uncontrolled blood glucose levels cause thickening of the inner lining (hyperplasia of the basal membrane) of large blood vessels and capillaries, disrupting blood flow to peripheral tissues in the legs and leading to necrosis, which results in diabetic ulcers (Lellu, 2021).

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Statistical results using the Spearman rank test on the relationship between body mass index and peripheral neuropathy in diabetes mellitus patients at the Gribig Kudus Health Center yielded a p-value of 0.004 with a correlation coefficient of -0.313. Since $p < 0.05$, a statistically significant relationship exists between body mass index and peripheral neuropathy in patients with diabetes mellitus. Additionally, the Spearman correlation coefficient of -0.313 indicates a weak negative relationship. A negative correlation means that as the body mass index increases, the monofilament test value decreases. The results of this study are consistent with a study conducted on 89 diabetes patients, which yielded a p-value of 0.032, indicating a significant relationship between body mass index and diabetic neuropathy in patients with diabetes mellitus (Anggraini & Purwanti, 2024). These results are consistent with a study conducted on 73 individuals using total sampling among diabetes mellitus patients, yielding 65 (89%) cases of diabetic neuropathy. The study found that 16 individuals had a normal BMI (24.6%), 14 were overweight (21.5%), and 35 were obese (53.9%). The analysis revealed a significant association between body mass index and diabetic neuropathy (Nasution, 2016). In line with a study conducted on 92 respondents, a p-value of 0.021 was obtained, indicating a relationship between body mass index and the severity of diabetic neuropathy (Aktifah *et al.,* 2022). Contrary to a study conducted on 68 respondents with type 2 diabetes (p-value 0.245), which stated that there was no association between body mass index and the risk of diabetic foot in patients with type 2 diabetes mellitus (AlKhotani *et al.,* 2023).

Based on the results of this study, the researchers concluded that there is a tendency for an increase in the incidence of peripheral neuropathy among respondents with a body mass index (BMI) exceeding the normal category. This finding suggests that obesity may be an essential risk factor that exacerbates neurological complications in diabetes mellitus patients. This can be explained physiologically, where excess body weight can lead to insulin resistance and damage to pancreatic beta cells, resulting in chronic hyperglycemia. This condition affects microcirculation, including peripheral tissues such as the feet, ultimately triggering the onset of diabetic neuropathy. Therefore, researchers suggest that weight control through lifestyle changes, such as a balanced diet and regular physical activity, should be an integral part of diabetes management to prevent or slow the progression of peripheral neuropathy.

The Relationship Between Foot Oxygen Saturation and Peripheral Neuropathy in Diabetes Mellitus Patients at Gribig Community Health Center

Based on statistical analysis of respondents categorized by foot oxygen saturation, the results showed that out of 82 respondents, 77 had normal foot oxygen saturation, 23 had neuropathy, 16 were at high risk, and 38 had normal monofilament test results. Five respondents had low oxygen saturation, with monofilament test results showing 1 case of neuropathy, 1 case at high risk, and 3 cases with expected results. Decreased peripheral oxygen saturation is caused by the presence of macroangiopathy in blood vessels, leading to impaired tissue circulation. Sorbitol accumulation in the vascular intima and hyperlipoproteinemia caused by hyperglycemia result in vascular obstruction due to thickening of the intima (arterial basal membrane hyperplasia) in large blood vessels and capillaries, which can even cause albumin leakage out of the capillaries, disrupting blood distribution to tissues and impairing blood circulation. Impaired blood circulation in the lower extremities can reduce oxygen delivery to tissues, leading to decreased peripheral oxygen saturation (Sukarja & Sukawana, 2020).

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Statistical analysis using the Spearman rank test on the relationship between foot oxygen saturation and peripheral neuropathy in diabetic patients at Gribig Kudus Health Center yielded a p-value of 0.615 with a correlation coefficient of 0.056. A p-value greater than 0.05 indicates that the relationship is not statistically significant. Therefore, the overall results suggest that there is no meaningful relationship between foot oxygen saturation and the other variables. The results of this study are consistent with a study titled "Education and guidance on Buerger-Allen exercises and the five pillars for changes in knowledge and physical health performance in diabetic patients with peripheral neuropathy," conducted on 28 diabetic patients with peripheral neuropathy who were previously examined at the Gundih Health Center. The results showed that foot oxygen saturation levels in diabetic patients with peripheral neuropathy, before and after education, were regular, with an average of 97% (Qomariah *et al.,* 2023).

The results of this study are inconsistent with a study conducted on 163 participants with type 2 diabetes and 63 healthy individuals. The findings indicated that among the diabetes group, the presence of diabetic peripheral neuropathy (DPN) was associated with impaired skin perfusion. Low oxygen pressure in DPN subjects could lead to delayed healing of diabetic feet (Eleftheriadou *et al.*,, 2019). A study conducted on patients with diabetic peripheral neuropathy involving 36 respondents showed a significant negative correlation between the degree of diabetic peripheral neuropathy (measured using the Toronto Clinical Scoring System/TCSS) and tissue oxygen saturation in the feet (measured using Transcutaneous Partial Oxygen Pressure/$TcPO_2$). The higher the degree of neuropathy, the lower the $TcPO_2$ value, indicating reduced tissue oxygenation (Asir *et al.*,, 2020). A study titled "The Effect of Diabetes Foot Exercises on Ankle-Brachial Index and Oxygen Saturation in Elderly Patients with Prolactin at Jambu Kulon Health Center" involving 20 participants, with approximately 60% reporting symptoms such as numbness and tingling, Oxygen saturation measurements obtained before intervention showed the lowest value of 92% and the highest of 96%, with an average of 94.05%, which is classified as low (<95%) (Damayanti *et al.,* 2023).

Improving blood flow through various activities is crucial for patients with peripheral neuropathy in diabetes, as it can help enhance blood circulation in the extremities, alleviate pain, and accelerate the healing process of nerves damaged by reduced blood flow. A study was conducted on 38 patients with diabetes mellitus, divided into two groups: 19 patients who received range of motion (ROM) exercises and 19 patients who did not. Vascularity data in the legs were measured using the ankle-brachial index (ABI). The results showed that vascularity improved before and after intervention in the experimental group (ROM exercise) compared to the control group, concluding that range of motion (ROM) exercise is effective in improving leg vascularity in diabetic patients (Sukarmin & Syafik, 2018). This indicates that structured physical activity can improve tissue oxygenation through increased peripheral perfusion. Another study found that foot exercises with music not only reduced blood sugar levels but also significantly increased oxygen saturation in type 2 diabetes patients (Setiawan *et al.*,, 2024). These findings support the theory that light and regular exercise helps improve blood circulation and peripheral tissue oxygenation.

The study results showed no significant association between foot oxygen saturation and peripheral neuropathy in diabetes mellitus patients (p-value > 0.05). Although theoretically, reduced tissue oxygenation could occur due to vascular dysfunction caused by diabetes, these findings indicate that foot oxygen saturation is not a sensitive indicator of peripheral neuropathy. Some studies also support that patients with neuropathy may still have normal oxygen saturation. However, physical activity has been proven to improve tissue perfusion and oxygenation, contributing to nerve condition

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improvement. Therefore, interventions such as foot exercises remain relevant in efforts to prevent and manage neuropathy complications in diabetes.

The Relationship Between Body Mass Index (BMI) and Foot Oxygen Saturation with Peripheral Neuropathy in Diabetes Mellitus Patients at Gribig Community Health Center

The results of the study indicate a significant association between body mass index (BMI) and peripheral neuropathy in patients with diabetes mellitus. Based on Spearman's statistical test, a p-value of 0.004 was obtained, which is less than 0.05, indicating a statistically significant association. Additionally, a correlation coefficient of -0.313 suggests that this relationship is negative with a weak category. This means that the higher the BMI, the lower the results of the monofilament test, which indicates peripheral neuropathy. In this context, obesity or being overweight is a significant risk factor that can worsen neurological complications in diabetes patients. An increase in BMI, especially beyond the normal range, leads to insulin resistance and damage to pancreatic beta cells, resulting in chronic hyperglycemia. This hyperglycemia can damage blood microcirculation, particularly in the lower extremities, leading to diabetic neuropathy. Reduced blood flow to the legs and impaired blood circulation can cause nerve damage, further increasing the prevalence of neuropathy in obese individuals. This impaired blood circulation can lead to thickening of the inner lining of large blood vessels and capillaries, disrupting oxygen distribution to lower extremity tissues, causing sensory disturbances, and ultimately neuropathy. These findings align with studies showing that most diabetes patients with peripheral neuropathy have a BMI above normal, particularly in the obese category. Obesity affects the body's ability to manage glucose, contributing to vascular and nerve damage, thereby worsening peripheral neuropathy in diabetes mellitus patients.

The relationship between foot oxygen saturation and peripheral neuropathy in diabetes mellitus patients at Gribig Health Center showed non-significant results. Based on Spearman's statistical test, the p-value of 0.615 indicates that the relationship between foot oxygen saturation and peripheral neuropathy is not statistically significant. Although there is a decrease in tissue oxygenation due to vascular disorders, this finding suggests that foot oxygen saturation is not a sensitive indicator of the presence of peripheral neuropathy in diabetes patients. Decreased oxygen saturation in foot tissues is generally caused by disorders in large blood vessels and capillaries due to macroangiopathy occurring in diabetes patients with chronic hyperglycemia. This can reduce the tissue's ability to receive oxygen, which is essential for tissue healing and maintaining nerve function. However, despite reduced tissue oxygenation, some studies indicate that patients with peripheral neuropathy may still exhibit normal oxygen saturation levels. Reduced tissue oxygenation does not always directly correlate with the severity of neuropathy experienced. For example, a study by (Qomariah *et al.*,, 2023) found that patients with peripheral neuropathy in diabetes had normal oxygen saturation in their feet. This suggests that despite impaired blood circulation, oxygen saturation does not always decrease significantly in patients with peripheral neuropathy.

Some studies suggest that physical activity and exercise, such as foot exercises, can improve blood perfusion and tissue oxygenation, which in turn can enhance neuropathy conditions and accelerate the healing process of damaged nerves. Overall, the results of this study indicate a significant association between body mass index and peripheral neuropathy in patients with diabetes mellitus, suggesting that obesity or overweight can increase the risk of peripheral neuropathy. Conversely, foot oxygen saturation did not show a significant association with peripheral neuropathy, although reduced

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tissue oxygenation may occur due to vascular dysfunction in diabetes. Therefore, maintaining a healthy body weight and engaging in regular physical activity remain essential for preventing or slowing the progression of peripheral neuropathy in individuals with diabetes mellitus.

Conclusion

This study aims to investigate the relationship between body mass index (BMI) and foot oxygen saturation in relation to the occurrence of peripheral neuropathy in patients with diabetes mellitus in the working area of the Gribig Kudus Community Health Center. Out of a total of 82 respondents, it was found that 24 individuals (29.3%) had peripheral neuropathy, 17 individuals (20.7%) were at high risk, and 41 individuals (50%) had normal test results. Most respondents had a BMI in the normal category (42.7%), while the remainder were categorized as underweight, obesity grade 1, and obesity grade 2. On the other hand, the majority of respondents (93.9%) had foot oxygen saturation levels still within the normal range. The analysis results showed a significant association between BMI and peripheral neuropathy. At the same time, foot oxygen saturation did not have a statistically significant association with the occurrence of peripheral neuropathy in patients with diabetes mellitus.

This study makes a significant contribution to the advancement of knowledge, particularly in the fields of community nursing and chronic disease management. The uniqueness of this study lies in its integrative approach, which simultaneously assesses two physiological indicators at the primary healthcare level. This topic has rarely been studied explicitly in local contexts, such as the Gribig Community Health Center. The practical implications of these findings suggest that weight control through nutrition education and regular BMI monitoring can be an effective strategy in preventing neuropathy complications in patients with diabetes mellitus. Additionally, although oxygen saturation was not found to be significantly associated in this study, maintaining optimal peripheral circulation through physical activity interventions and simple exercises remains essential. From a managerial perspective, health centers can use the results of this study as a basis for designing risk-based health promotion programs and individual interventions tailored to patients' BMI profiles.

The limitations of this study include its cross-sectional design, which does not allow for the exploration of causal relationships over time. Additionally, the small sample size and focus on a single health center work area limit the generalizability of the findings. The use of a simple pulse oximeter for measuring oxygen saturation may also introduce variability in the measurement results. Therefore, for future research, it is recommended that a longitudinal or cohort study be conducted to evaluate changes in BMI and oxygen saturation over a specific period and their impact on the development of peripheral neuropathy. Researchers are also advised to consider other factors such as HbA1c levels, diabetes duration, and physical activity, which may influence the occurrence of peripheral neuropathy, to achieve a more comprehensive understanding.

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