Journal of Bionursing
2025, VOL.7, NO. 3, 136-154

Combination Foot Care and Massage Reducing Peripheral Neuropathy Symptoms in Clients with Diabetes Mellitus

Arida Auliya[1], Dewi Hartinah[2], Muhamad Jauhar[3] ✉, Lasmini[4]

[1, 2, 3, 4] Faculty of Health Sciences, Universitas Muhammadiyah Kudus, Jl. Ganesha Raya No. 1 Purwosari Kudus, Indonesia
✉ Correspondence Author : muhamadjauhar@umkudus.ac.id

ABSTRACT

Diabetes Mellitus (DM) is the most challenging public health problem in the 21st century. This disease is classified as chronic, and its treatment is a challenge for the global health care system. The increasing prevalence of DM is a side effect of the transformation of life. The rise in DM complications has a serious impact on the quality of life of DM clients. Complications of this disease continue to worsen the client's condition if they do not receive appropriate intervention, leading to dysfunction in almost every organ of the body. DM complications account for the largest portion of the National Health Insurance (JKN) program's medical expenses. The aim of this study was to analyze the effect of a combination of foot care and massage on symptoms of peripheral neuropathy in DM clients. The research design used a quasi-experimental pre-posttest with a control group. The independent variable is a combination of foot care and massage, while the dependent variable is the symptoms of peripheral neuropathy. This study was conducted on diabetes mellitus in April 2025. The study sample consisted of 14 DM clients for each intervention and control group, using a purposive sampling technique based on inclusion and exclusion criteria. The research instrument used was 10 g monofilament. Combination therapy foot care and massage are given 3 times per week for 2 weeks, with a duration of 25-30 minutes per session. Data analysis used the Wilcoxon test and the Mann-Whitney test. The results of the study showed that there was a combined effect of foot care and massage on symptoms of peripheral neuropathy in DM clients with a p-value of 0.000 ($p<0.05$). Combination therapy/foot care and massage has a positive effect in reducing symptoms of peripheral neuropathy in DM clients. Follow-up is needed to integrate this combination therapy with community health activities, especially for DM clients.

KEYWORDS
Diabetes mellitus; foot care; massage; peripheral neuropathy

INTRODUCTION

The most challenging public health problem of the 21st century is the Diabetes *Mellitus* (DM) (Lim et al., 2021). This disease is classified as a chronic disease, and its treatment poses a challenge to the global healthcare system. The disease's silent onset without clinical manifestations and its rapid progression have led many experts to call it DM *silent killer* (Darmawan et al., 2024). Due to the severity of this disease, nearly half of patients are accidentally diagnosed with DM. Macrovascular and microvascular damage, as well as organ dysfunction, are indicators that complications from this disease can be quite fatal (Berbudi et al., 2019). Deaths from this incident reach 6.7 million annually (Ekavito & Rakhmawati, 2023). The economy of DM patients, their families, and even the country is significantly impacted by this incident.

DM continues to threaten human health globally, becoming the most common predictor of global mortality and morbidity. Aging populations, urbanization, poor dietary habits, and lack of physical activity are the main triggers for the increasing prevalence of DM. (Prabowo et al., 2023). Recorded in 2023 by the International *Diabetes Federation (IDF),* the frequency of DM clients is 540 million people. (International Diabetes Federation, 2023).

Global health predictions indicate that the cost of healthcare for DM patients is $966 billion, and this

will continue to rise to over $1,054 billion by 2045 (Hossain et al., 2024). This data demonstrates that each country faces significant costs to contribute to DM care.

The prevalence of diabetes mellitus (DM) continues to explode in Indonesia. This surge in prevalence has resulted in significant budgetary losses, particularly for DM clients, their families, and even the Indonesian government. As part of the membership of the *World Health Organization (WHO),* Indonesia certainly provides a comprehensive health program for its citizens by providing the National Health Insurance (JKN). This means that the Indonesian government has a significant responsibility for the cost of treating all illnesses.

Diabetes complications continue to account for the largest portion of medical expenses under the National Health Insurance (JKN) program, accounting for 33% of total expenditures (Fatmawati et al., 2021). In Indonesia, costs for diabetes patients with complications are twice as high as for those without complications, ranging from $903 to $1,480 per person annually (Firman & Lestari, 2024). Information regarding the prevalence of DM worldwide shows that the total number of DM patients has consistently increased over the past decade. There is serious concern that this incident will continue to soar. The resulting increase in incidence is estimated to reach 643 million (11.3%) patients by 2030 and 783 million (12.2%) by 2045 (Hossain et al., 2024).

The majority of DM clients come from low- and middle-income countries. (Darmawan et al., 2024), *International Diabetes Federation* The 2019 update stated that 29 million people live with diabetes in Southeast Asia. Indonesia is categorized as a densely populated middle-income country and ranks fifth with 19.5 million cases.

The incidence of deaths due to diabetes mellitus (DM) ranks third as the leading cause of death in the Indonesian field (Darmawan et al., 2024). According to the 2023 Indonesian Health Survey, which examines the prevalence of medical diagnoses in each province across all age groups, the number of DM patients in Indonesia with a weighted n value is 877,531 (Survei Kesehatan Indonesia, 2023). Meanwhile, according to data from the 2023 Central Java Provincial Health Profile, **it** was recorded that the proportion of non-communicable diseases DM was ranked third after obesity, with a percentage of 9.59%. (Dinas Kesehatan Jawa Tengah, 2023)

Based on data from the 2023 Kudus Health Profile, the number of DM clients in Kudus Regency reached 18,329, of which 17,440 had received health services in the (Dinas Kesehatan Kudus, 2023). According to a report from a community health center in a village with a DM prevalence in Kudus Regency, there were approximately 873 cases of Impaired Glucose Tolerance (IGT) with insulin from January to December 2024.

The increasing prevalence of diabetes mellitus (DM) is a side effect of the transformation of life from traditional to futuristic. The relaxed lifestyle choices sought by today's youth are significantly linked to the increase in the incidence of adolescents diagnosed with diabetes. Furthermore, the impact of the prevalence of diabetes mellitus (DM) is significant *junk food* and *soft drink* Currently, the prevalence of DM is increasing; this is proven by the results of the glycemic

index from *junk food* and *soft drinks affecting* the rate of increase in blood sugar (Trias Wari et al., 2022). This incident is also concerning and will continue to pose a serious threat to the health status of the younger generation.

The increasing number of DM complications also has quite a serious impact on quality *of life in* DM clients (Fanani & Sulaiman, 2021). The longer a person suffers from DM, the more severe the complications become, and without proper intervention, it can lead to dysfunction in almost all organs of the body (Kurnia et al., 2022). Macrovascular and microvascular disorders are structural and functional complications of blood vessels caused by hyperglycemia (Saputri, 2020). These conditions affect various organs such as the heart, kidneys, and nerves.

Examples of complications include retinopathy, which can lead to blindness, and peripheral neuropathy, which can be fatal. Often unnoticed symptoms of peripheral neuropathy signal the beginning of diabetes complications and, if left untreated, worsen the condition and increase medical costs. If this incidence continues to increase, the financial burden borne by the Indonesian government will increase (Mas Ulfa et al., 2023). The Indonesian government must take decisive action, considering that Indonesia is still classified as a middle-income country.

Given the impact of DM complications and the high cost of treatment, it is important for clients to detect early symptoms to minimize complications. Based on an initial survey conducted by researchers in the Posbindu program in a village in Kudus Regency, which served as the locus, 5 out of 7 clients surveyed experienced symptoms of peripheral neuropathy. Regarding the interventions that have been carried out by the PJ PTM DM at the Community Health Center in an effort to reduce the prevalence of DM and its complications, they focus on controlling blood sugar levels and preventing complications due to DM through educational activities on maintaining a healthy diet, recommendations for a low-sugar diet, and encouragement to regularly carry out physical activity screening for DM clients. This activity took place at a community health center in a village in Kudus Regency, which serves as the location for DM and Posbindu in each village within the community health center's work area.

Due to the high cost of treating complications of diabetes, clients should be provided with information about non-pharmacological treatments to reduce the financial burden and to enable them to self-administer. One relatively unknown, effective therapy is foot *care.* This therapy involves several steps and is relatively easy to apply (Kurnia et al., 2022). *Foot care*, a non-pharmacological treatment that is quite easy to implement for every DM client, is massage. Considering the many benefits of massage, every DM client should be introduced to this treatment method.

Based on research conducted by (Kurnia et al., 2022) who conducted research to identify the effectiveness of foot care for peripheral neuropathy symptoms in DM clients with the Michigan *Neuropathy Screening Instrument*, it was found that the intervention could reduce peripheral neuropathy complications in DM clients. Similarly, a study by (Taher M. Al-Fahham & Mohammed B. Al-Jubouri, 2024), with similar results, found an effect after being given foot massage therapy and ROM exercises in

reducing peripheral neuropathy complications. The study stated that foot massage intervention was more effective than ROM exercises.

Based on the previous research described above, the study was conducted in different research location settings and using different instruments to measure peripheral neuropathy variables. Therefore, the researchers wanted to conduct this study and specifically determine whether the combination of foot *care* and *massage can* help reduce symptoms of peripheral neuropathy in DM clients. Based on a survey conducted by researchers in the work area of a Community Health Center in a village in Kudus Regency that is a DM locus, DM clients are not yet aware of non-pharmacological therapeutic interventions like *foot care* and *massage*.

By conducting this research, it is hoped that it will be useful, especially in the development of nursing science regarding non-pharmacological therapy, *foot care,* and *massage* to reduce the symptoms of peripheral neuropathy in DM clients. This research is expected to broaden knowledge and provide alternative non-pharmacological therapies for the general public, particularly those living in the community health center area of a village in Kudus Regency, as a treatment to help reduce the symptoms of peripheral neuropathy.

In addition, by conducting this research, several roles of nurses have been implemented. The role of nurses in the research process is as follows: *caregiver, educator, and researcher*. The role of caregiver is described in the form of providing interventions, *foot care,* and *foot massage to* DM clients. The role of the educator is described by providing education in the form of an introduction to non-pharmacological therapy, *foot care,* and *foot massage. As researchers,* nurses research the effects of combination foot *care* and *foot massage on* symptoms of peripheral neuropathy in DM clients. The aim of this study was to analyze the effect of the combination of foot *care* and *massage on* symptoms of peripheral neuropathy in DM clients.

METHOD

The research design uses a quasi-experimental *pre-posttest with a control group*. The independent variable is a combination of foot *care* and *massage,* while the dependent variable is the symptoms of peripheral neuropathy. This research was conducted in a village in Kudus Regency, which was the DM locus in April 2025. The research sample consisted of 14 DM clients for each intervention and control group, using a purposive sampling technique.

Inclusion criteria: type 2 DM clients with blood glucose levels ≥200 mg/dl, without gangrene wounds, including those who have or have had foot wounds due to DM (including amputations, open wounds, or healed wounds), aged 19–65 years. Exclusion criteria: clients with foot fractures, swelling or inflammation of the foot, deep vein thrombosis, or uncooperativeness during the intervention.

The research instrument used 10-gram monofilament according to the British Columbia Provincial Nursing Skin & Wound Committee (2022) guidelines (CLWK, 2022). The steps were ensuring a safe environment, asking the client to remove footwear, washing hands, putting on gloves, and explaining the procedure. Before the examination, the monofilament was applied to the client's hands to

identify the sensation. The client then closed their eyes and responded "yes" to the sensation of the stimulation on their feet.

The test is performed on 10 points on the foot by pressing the monofilament perpendicularly until it bends approximately 1 cm for approximately 2 seconds. Repeat three times if there is no response, then repeat on the other foot. A score of 1 is given if it is felt, and a score of 0 otherwise. After the test, gloves are removed, hands are washed, the monofilament is cleaned, labeled with the name and date, and then stored in a clear plastic bag at room temperature. A score of 10/10, 9/9, or 8/10 is considered normal, while <8 indicates neuropathy.

Combination therapy *foot care* and *massage The* study was administered three times a week for two weeks, with a duration of 25–30 minutes per session. Data were analyzed using the Wilcoxon test and the Mann–Whitney test. This study was a quantitative study with a cross-sectional design *quasi-experiment pre-posttest with a control group. This* study involved two randomly selected groups (intervention and control), with the assessment comparing pretest and posttest scores. Each group was given a pretest to find out the initial conditions or initial state before the client is given intervention, and after the intervention is given, the client is given a final test (*posttest*) to find out the final condition or state of the client.

The intervention group was given a pretest and posttest using 10 g monofilament to measure foot sensitivity, with the intervention foot *care* and *massage given* 3 times per week for 2 weeks. This study used observational data collection techniques. The independent variables were measured using a combination of SOP *foot care* and *massage*, while the dependent variable was measured with 10 gr monofilament according to the British Columbia Provincial Nursing Skin & Wound Committee (2022) guidelines (CLWK, 2022).

The study began with measurement of peripheral neuropathy using 10 gr monofilament (pretest) in the intervention group. Foot *care* includes trimming nails, cleaning and brushing feet, drying between the toes, applying lotion/cream to dry skin, wearing cotton socks, and providing appropriately sized and safe footwear. Tools used include client and therapist chairs, towels, washcloths, basins, tissues, masks, aprons, nail clippers, gloves, foot brushes, soap, and clean water (Wardani & Nugroho, 2019).

Thai massage is performed with the client lying on their back or side or sitting, applying gradual pressure using the thumbs to the knees, legs, ankles, and soles of the feet along three meridian lines for 5–10 seconds at each point, stopping if discomfort occurs. The intervention lasts 25 minutes, three times a week for two weeks, using tissues, oil/lotion, and gloves (Mulia, 2019). Data analysis used the Wilcoxon test and the Mann-Whitney test.

RESULT AND DISCUSSION

Diabetes Mellitus Clients' Characteristics

Table 1. Characteristics of Diabetes Mellitus Clients with Peripheral Neuropathy Based on Age (n=28)

Characteristics	Intervention		Control	
	Mean	SD	Mean	SD
Age	55.21	9.2	58.93	4.698

Table 1 shows that in the intervention group, the average age of DM clients experiencing peripheral neuropathy was 55.21 years with a standard deviation (SD) of 9.2. Meanwhile, in the control group, the

average age of DM clients with peripheral neuropathy was 58.93 years with a standard deviation (SD) of 4.698.

The study results showed that the majority of DM clients experiencing peripheral neuropathy were elderly, aged 55.21 years in the intervention group and 58.93 years in the control group. With age, the body naturally experiences declines and changes in functions, such as the immune, metabolic, endocrine, sexual, cardiovascular, gastrointestinal, muscular, and nervous systems. These changes begin in cells, then in tissues, and ultimately in organs, which can affect homeostasis (Oktavia et al., 2024). Aging in DM patients, especially those with type 2 DM, results in decreased peripheral blood flow. This leads to decreased nutrient uptake to these areas, particularly the lower extremities (Rasyid et al., 2020).

Nerves lack blood vessels, so they rely on the diffusion of nutrients and oxygen. Hyperglycemia in diabetic patients damages blood vessels and blood flow, impeding the delivery of nutrients and oxygen to the nerves (Sitorus1 et al., 2023). This condition ultimately leads to nutritional deficiencies in the peripheral region and worsens the patient's neuropathy (Rasyid et al., 2020)

In addition to reduced peripheral blood flow, another common decrease is decreased insulin production by pancreatic β cells (Siregar, 2021). Decreased insulin production due to decreased pancreatic function leads to unstable blood sugar and insulin resistance, which narrows blood vessels and damages nerves, particularly in the legs and feet (Rasyid et al., 2020).

The results of this study align with research conducted by (Nurjannah et al., 2023), which showed that the majority of DM clients with peripheral neuropathy complications were aged 46-65 years. Another study conducted by (Suharni et al., 2022) showed that the majority of DM clients with diabetic neuropathy complications were aged 56-65 years, totaling 24 people (46.2%).

Based on the research results above, age significantly influences the incidence of neuropathy in DM patients. The longer a person has DM, the greater the risk of peripheral neuropathy due to decreased body function and insulin production, which leads to unstable blood sugar levels and damages blood flow and nerves, particularly in the feet and legs.

Table 2. Characteristics of Diabetes Mellitus Clients with Peripheral Neuropathy Based on Gender, Education Level, Occupation, and Income (n=28)

Characteristics	Intervention		Control	
	f	%	f	%
Gender				
Man	0	0	3	21.4
Woman	14	100	11	78.6
Level of education				
No school	3	21.4	5	35.7
Elementary school graduate/equivalent	9	64.3	9	64.3
Graduated from junior high school/equivalent	1	7.1	0	0
High school graduate/equivalent	1	7.1	0	0
Work				
Doesn't work	8	57.1	10	64.3
Housewife	1	7.1	1	7.1
Farmer	1	7.1	0	0
Laborer	3	21.4	2	14.3
Trader	1	7.1	1	7.1
Income				
Have no income	9	64.3	11	78.6
<RMW (IDR 2.680.485,72)*	5	35.7	3	21.4
History of Diabetes Mellitus				
≥6 Months	14	100	14	100
Total	**28**	**100**	**28**	**100**

***) Kudus Regency Minimum Wage in 2025**

The results showed that the majority of clients with diabetes were women, both in the intervention and control groups: 14 (100%) in the intervention group and 11 (78.6%) in the control group. Women are at greater risk of developing diabetes than men, as women have higher levels of the hormones progesterone and estrogen than men. Both hormones have the potential to increase the insulin response in the blood.

The estrogen hormone content in women's bodies also triggers a predominant female risk of developing diabetes complications, namely neuropathy. Disrupted iodine absorption in the intestines results in impaired nerve myelin formation. Thus, women are at risk of developing diabetes complications, namely peripheral neuropathy (Nurjannah et al., 2023). Women entering menopause experience a decreased insulin response due to low levels of progesterone and estrogen (Arania et al., 2023). Low estrogen levels in menopausal women increase abdominal fat reserves, accelerate the release of free fatty acids, and trigger insulin resistance (Milita et al., 2021). Women have a higher body fat percentage (20–25% of body weight) than men (15–20%), putting them at 3–7 times greater risk of developing diabetes (Sinurat et al., 2025)

Besides hormones, another factor that puts women at risk of developing diabetes is a lack of physical activity (Oktavia et al., 2024). Physical activity plays a crucial role in energy combustion. Lack of physical activity reduces energy burning, causing excess energy to be stored as fat, leading to obesity (Arania et al., 2021). Obesity reduces the number of optimally functioning insulin receptors in muscle cells and adipose tissue (Adyas et al., 2022)

The results of this study are in line with research conducted by (Suharni et al., 2022), in which the majority of DM clients with neuropathy complications were women, totaling 36 people (69.2%), while only 16 men experienced DM with neuropathy complications. In another study conducted by (Nurjannah et al., 2023), the majority of DM clients with neuropathy complications were women (33 people, 71.7%) compared to men (13 people, 28.3%). Based on the research results above, gender significantly influences the incidence of diabetes. The decline in estrogen and progesterone hormones during menopause reduces insulin production, which is exacerbated by a lack of physical activity, which triggers fat accumulation and obesity, thus increasing the risk of diabetes.

The results showed that the majority of DM clients had an elementary school education or equivalent in both the intervention and control groups. Educational level influences DM risk; highly educated clients tend to have health knowledge that helps maintain a healthy lifestyle and diet, reducing the risk of DM (Lubis et al., 2023).

Education level influences the risk of diabetes mellitus (DM), as differences in mindset between those with higher and lower levels of education influence daily food choices. (Oktavia et al., 2024). In addition to food choices, highly educated DM clients can manage mealtimes effectively to prevent DM complications caused by uncontrolled eating habits that trigger hyperglycemia. (Ritonga et al., 2022). The results of the study are in accordance with research conducted by (Arania et al., 2023) the study showed that the majority of DM clients had basic education (60 people) with $p = 0.000$ (<0.05). Another study conducted by

(Oktavia et al., 2024) showed p = 0.000, with the majority of DM clients (76 people) having low education (elementary–junior high school); higher education increases awareness of maintaining health, while low education is at risk of paying less attention to lifestyle and diet.

The majority of DM clients in both the intervention and control groups in this study were unemployed: 8 (57.1%) in the intervention group and 10 (64.3%) in the control group. Employment is a contributing factor to DM. Being unemployed can lead to reduced physical activity. Physical activity improves muscle glucose recovery because muscles use stored glucose, which is then replaced by glucose from the blood, lowering blood sugar levels (Arania et al., 2021). This reduces the risk of hyperglycemia in patients and the risk of diabetes complications such as peripheral neuropathy. Lack of activity causes food to be stored as fat and sugar, increasing both levels and triggering diabetes due to insufficient insulin converting glucose into energy (Irayani, 2024).

The above statement is supported by research results that are in line with the researchers. Conducted by (Oktavia et al., 2024), the study showed that 66 unemployed people had DM with GDS >200 mg/dl, with p = 0.000. (Arania et al., 2021), in their research, showed the results of the value p=0.002 (p<0.05). Likewise, research conducted by (Milita et al., 2021) obtained results with a p-value of 0.000 (p<0.05). In his research, 3,321 clients were categorized into two categories: light-moderate work, with 3,321 clients, and heavy work. Therefore, it can be concluded that work is related to the incidence of diabetes because physical activity during work uses up muscle glucose, thereby utilizing excess blood glucose and reducing the risk of hyperglycemia.

The majority of clients in the intervention and control groups in this study had no income, with 9 clients (64.3%) in the intervention group and 11 clients (78.6%) in the control group. Income influences food choices; low-income clients have difficulty meeting balanced nutritional needs (Hidayad, 2025). Low income makes clients more likely to choose cheap, high-calorie foods, which can increase the risk of obesity and diabetes.

Food selection and carbohydrate management are important for DM clients for health, energy, weight, and blood sugar stability and to support nerve function in the peripheral neuropathy. (Ritonga et al., 2022). Low income limits access to and knowledge of health, making clients less likely to check or monitor their blood sugar. (Hidayad, 2025)

This statement is supported by the results of a study conducted by (Hidayad, 2025) that is in line with this study. The results showed p = 0.033 (<0.05), with 73% of clients earning <UMR and 27% ≥UMR suffering from DM. Another study conducted by (Faizal et al., 2024) obtained results with a p-value of 0.018 (p<0.05), indicating a significant relationship between income and diabetes. Thus, income influences food choices in diabetes patients. Low income limits access to balanced nutrition, increases consumption of high-calorie foods, and reduces access to health services and blood sugar monitoring, thus worsening diabetes and peripheral neuropathy.

Based on the research results, the majority of clients in both groups had diabetes for ≥6 months, with 14 individuals (100%) in each group having diabetes

for ≥6 months. Long-term high blood sugar levels in DM clients thicken the blood vessel walls and damage capillaries and nerve fibers, resulting in peripheral neuropathy (Waruwu & Afnijar Wahyu, 2024). Long-term hyperglycemia increases polyol pathway activity, leading to sorbitol accumulation and decreased myoinositol levels in nerve cells (Sitorus1 et al., 2023). This condition disrupts nerve signaling, reducing foot sensitivity and pain sensitivity in diabetic patients, especially if glycemic control is poor. Chronic hyperglycemia forms AGEs that trigger ROS, oxidative stress, microangiopathy, and pain-causing nerve dysfunction (Tofure et al., 2021). This is supported by research conducted by (Waruwu & Afnijar Wahyu, 2024), which showed p = 0.002 (p < 0.05), with 68.4% of DM clients having >5 years and 31.6% having <5 years. Research by Tofure et al. (2021) found that 75% of DM clients had more than 5 years and 25% had 1–5 years. Based on this description, prolonged diabetes mellitus (DM) contributes to the development of peripheral neuropathy. Unstable blood sugar levels thicken the walls of the blood vessels supplying the nerves, gradually damaging the capillaries and nerve fibers.

Peripheral Neuropathy Score in Diabetes Mellitus Clients

Table 3. Peripheral Neuropathy Score in Diabetes Mellitus Clients in the Intervention Group and Control Group (n=28)

Peripheral Neuropathy Score	Intervention		Control	
	f	%	f	%
Before <8 (Peripheral Neuropathy Occurs)	14	100	14	100
After <8 (Peripheral Neuropathy Occurs)	4	28.6	14	100
≥8 (Normal or No Peripheral Neuropathy)	10	71.4	0	0

Table 3 presents the peripheral neuropathy scores before and after the intervention in the intervention and control groups. Before the intervention, both the intervention and control groups experienced peripheral neuropathy, with 14 individuals (100%) in each group. After the intervention, there was a decrease in the frequency of peripheral neuropathy in the intervention group, with 4 individuals (28.6%) still experiencing peripheral neuropathy and 10 individuals (71.4%) remaining in normal condition or without peripheral neuropathy. Meanwhile, there was no change in the control group after the intervention. This is evidenced by the frequency of clients still experiencing peripheral neuropathy, which was 14 individuals (100%).

Based on the research results, the majority of DM clients in two groups experienced peripheral neuropathy, with 14 clients in each group experiencing peripheral neuropathy after testing using monofilament. Peripheral neuropathy is a complication of DM characterized by nerve disorders, particularly in the central and peripheral nerves (Zhu et al., 2024). Based on client surveys, the most common symptoms experienced by clients are pain and tingling in the legs. Damage to sensory nerves can lead to pain when the feet are touched (allodynia) and increased sensitivity to stimuli that trigger pain (hyperalgesia) (Sim et al., 2023). Based on client interviews, three clients reported that tingling and pain symptoms often occurred at night. Peripheral neuropathy symptoms in DM clients are more pronounced at night because the clients are inactive and focus on bodily sensations, indicating this condition is serious and requires prevention of further complications (Agustini et al.,

2025). DM clients also experience narrowing of the blood vessels (atherosclerosis), which reduces blood flow to the lower extremities, resulting in pain at rest and during activity (Agustini et al., 2025).

Peripheral Neuropathy in Diabetes Mellitus Clients After Intervention *Foot Care* and *Massage*

Based on the research results, it was found that DM clients did not experience peripheral neuropathy or had reduced peripheral neuropathy in the intervention group, but in the control group all DM clients still experienced peripheral neuropathy. *Foot care is very* useful, especially for DM clients who have symptoms of peripheral neuropathy.

This is related to the condition of the client's feet, which are susceptible to wounds or complications on their feet, as well as the length of time required for the wound to heal (Saprianto et al., 2022). *Foot care* can be used for early detection to reduce the risk of foot complications. According to Orem's theory, this intervention emphasizes client independence, and its success is maximized when carried out intentionally and independently (Latipah & Apriyanti, 2022).

Besides *foot care*, non-pharmacological therapy for DM clients with peripheral neuropathy is massage, namely foot massage, to improve blood circulation, maximize nerve function, and reduce peripheral neuropathy (Taher M. Al-Fahham & Mohammed B. Al-Jubouri, 2024). Massage, if implemented on DM clients, of course, is the process of repairing damaged peripheral tissue.

Massage will cause superficial blood vessels to dilate, thereby increasing blood flow to all peripheral body parts experiencing delayed perfusion (Taher M. Al-Fahham & Mohammed B. Al-Jubouri, 2024), and allowing nutrients to enter nerve cells (Ren et al., 2022). Furthermore, *massage on* the feet also helps reduce pain due to diabetic neuropathy (Chatchawan et al., 2020).

Based on the research results, the control group did not show any change in scores because they only received verbal education about non-pharmacological therapy without direct intervention, so the symptoms before and after remained the same. This finding is in line with research conducted by (Taher M. Al-Fahham & Mohammed B. Al-Jubouri, 2024), where the control group did not experience significant changes (p = 0.256 > 0.05) because only a pretest and posttest were administered without intervention.

Differences in Peripheral Neuropathy Symptoms Before and After Intervention *Foot Care* and *Massage in* Clients with Diabetes Mellitus

Table 4. Differences in Peripheral Neuropathy Scores in Diabetes Mellitus Clients in the Intervention and Control Groups Before and After Intervention (n=28)

Group	p-value
Intervention	0.001
Control	1.000

Table 4 shows that there is a statistically significant difference between the peripheral neuropathy scores before and after the intervention in the intervention group with the Wilcoxon test; the significance value obtained is *p=0.001* (*p*<0.05). Meanwhile, in the control group, there was no significant difference between the peripheral neuropathy scores before and after the intervention, with a significance value of p=1.000 (p>0.05).

Based on the research results, it shows that there are differences in symptoms before and after the

intervention of giving *foot care* and *massage in* the intervention group. The difference in symptoms before and after the intervention in the intervention and control groups is the effect of the non-pharmacological therapy. Other complications, such as the emergence of diabetic ulcers, can be minimized by implementing foot *care*, (Ayu et al., 2024).

The same goes for doing massage; a reflex action will occur in the nerves and blood circulation, stimulating local vasodilation and smoothing blood circulation, as well as reducing pain responses in the peripheral nerves of diabetic clients (Eppang & Prabawati, 2020). Foot massage in diabetic clients triggers the dilation of small blood vessels and encourages venous blood to return to the heart.

Improving blood flow is crucial for healthy foot nerves and reducing neuropathy symptoms. Compression applied to the lower extremities, specifically the soles of the feet, which are the terminal part of the nervous system, will undoubtedly improve blood circulation (Lubis et al., 2023). This intervention lasted approximately 25-30 minutes per participant, three times per week, for two weeks, according to research conducted by (Taher M. Al-Fahham & Mohammed B. Al-Jubouri, 2024).

Based on the results of the study conducted by the researchers, it was found that there was no difference in neuropathy symptoms before and after the intervention in the control group. The control group only received verbal education about non-pharmacological therapy, which does not guarantee skills and compliance in implementing it. Without training and monitoring, the control group tended not to perform the intervention *foot care* and *massage* correctly and consistently.

This finding is in line with research conducted by (Taher M. Al-Fahham & Mohammed B. Al-Jubouri, 2024), the study showed that the control group did not experience significant changes ($p = 0.256 > 0.05$) because only pretests and posttests were carried out without intervention.

Influence of *Foot Care* and *Massage* Regarding Peripheral Neuropathy Symptoms in Diabetes Mellitus Clients

Table 5. Effect of Combination Foot Care and Massage on Peripheral Neuropathy Symptoms in Diabetes Mellitus Clients (n=28)

Group	p-value
Intervention	0.000
Control	

Table 5 shows that there is a statistically significant effect of the combination of foot *care* and *massage* on symptoms of peripheral neuropathy in DM clients. This is proven by the results of the Mann-Whitney test, which produces a significance value of p=0.000 ($p<0.05$). Based on the significance value, statistically it indicates that there is an influence from the combination of foot *care* and *massage* on symptoms of peripheral neuropathy in DM clients.

Based on the research results, it was found that the majority of DM clients with peripheral neuropathy in the intervention group experienced a reduction in symptoms. The results showed a statistically significant effect between the combination of *foot care* and *massage* on symptoms of peripheral neuropathy in DM clients.

This study aligns with research conducted by (Kurnia et al., 2022). The study showed a pretest

average of 20.5 and a posttest average of 23.5, with a Wilcoxon Signed Rank p = 0.001 (<0.05), indicating a significant difference in neuropathy symptoms before and after foot self-care. Another study by (Latipah & Apriyanti, 2022), stated that the Paired Simple T-Test yielded p = 0.000, indicating a significant change before and after the foot self-care intervention for peripheral neuropathy.

Foot care, if implemented correctly, can be used as a preventative measure or as a means of detecting foot abnormalities. By implementing *foot care* in their daily routine, DM clients tend to notice changes in their feet more quickly, as well as a primary prevention effort for complications. This is due to the fact that the procedure of foot *care* includes inspection activities, namely observations of the feet (Ayu et al., 2024)

Intervention *foot care refers* to Dorothea Orem's self-care theory, which emphasizes an individual's ability to meet their own needs to improve quality of life, health, and well-being. Self-care helps shape health-promoting behaviors and supports the optimal development of body structure and function. (Paisal, 2021)

In this theory, Orem emphasizes that it is important for nurses to teach each client to be independent based on their level of dependency (Paisal, 2021). The regularity of DM clients in carrying out*foot care* daily exercise can prevent a decline in quality of life and reduce complications such as peripheral neuropathy, with success depending on the client's intention and diligence (Latipah & Apriyanti, 2022)

Besides *foot care*, intervention massage in this study also had an effect on the symptoms of peripheral neuropathy in DM clients. This is in line with research conducted by (Taher M. Al-Fahham & Mohammed B. Al-Jubouri, 2024), showing a significant increase in the foot massage group, from pretest 14,320 ± 2,996 to posttest 15,880 ± 2,278 with p = 0.001 (<0.05). Another study conducted by (Agustini et al., 2022), research with 72 respondents at the North Denpasar Health Center, showed a pretest of 14.5 (6–39) and a posttest of 6.5 (0–27), with the Wilcoxon Sign Rank Test p = 0.000 (<0.05), indicating that foot massage had a significant effect on reducing peripheral neuropathy in type 2 DM clients.

Massage is a simple intervention using a gentle massage method that applies light or strong pressure to the extremities. With massage, a reflexive effect occurs, acting on the nerves and blood circulation, thus stimulating local vasodilation and smooth blood circulation, as well as reducing pain responses in the peripheral nerves of diabetic clients (Eppang & Prabawati, 2020). Compression applied to the lower extremities, specifically the soles of the feet, which are the terminal part of the nervous system, will certainly improve blood circulation (Novita et al., 2023)

Application of non-pharmacological therapy foot *massage* can increase the concentration of blood oxygen in body tissues. By applying touch and slight pressure to the area being treated, *massage* vasodilation, also known as widening of the blood vessels, occurs (Ekavito & Rakhmawati, 2023). Pressure on the extremities affects hormone function, increasing endorphin secretion, which plays a role in reducing pain (Hijriana & Miniharianti, 2022).

When the pressure is released, massage and reflex vasodilation of superficial blood vessels occur.

Muscle reflexes in the walls of the smallest blood vessels (arterioles) also contract. This increases oxygen concentration in the affected extremity. *Massage* Specifically, it affects the nerve tissue in the feet, triggering nerve cell repair. At the same time, massage also has the potential to reduce pain (Ren et al., 2022).

Pressure on the extremities helps venous blood flow back to the heart, with venous valves preventing blood from flowing back to the periphery. The venous emptiness allows arteriolar blood to fill the area (Ibrahim et al., 2020). As a result, blood circulation in the massage area improves, increasing the sensation of skin protection (Hastuti, 2020). The benefit of *massage* is to increase the sensitivity of stimuli in the feet of DM clients with peripheral neuropathy (Novita et al., 2023).

RESEARCH LIMITATIONS

The low interest of DM clients in attending the intervention location was due to limited mobility, with many respondents unable to ride a motorbike and lacking a companion to drive them to the location. This situation made it difficult for researchers to gather respondents at the same time and place. To overcome this obstacle and ensure the smooth running of the study, researchers chose to implement the intervention using the door-to-door method; namely, researchers visit each respondent at their residence to provide individual intervention.

This situation resulted in a high allocation of time and resources, given that each session required 25–30 minutes per respondent, conducted three times per week for two consecutive weeks. While this strategy allowed for better control over procedural compliance, it also extended the implementation time and increased the logistical burden of the study.

CONCLUSION AND RECOMMENDATION

The results of the study showed that there was a combined effect of *foot care* and *massage* on symptoms of peripheral neuropathy in DM clients. *Foot care,* if done correctly, can be a preventive measure and early detection of foot abnormalities through routine inspections so that abnormalities can be treated immediately and the risk of complications minimized. *Massage* helps improve blood circulation through pressure on the extremities, which increases the sensation of skin protection.

The community is encouraged to implement non-pharmacological therapy, *foot care,* and *massage consistently to* reduce the symptoms and progression of peripheral neuropathy, especially in people with diabetes. Health workers at community health centers are expected to educate the public about this therapy procedure through programs such as counseling, integrated health posts (Posbindu), or diabetes education classes to suppress the progression of peripheral neuropathy, minimize the risk of diabetic foot disease, and improve the client's quality of life.

The results of this study can serve as a reference for health students, particularly nursing students, regarding non-pharmacological interventions for peripheral neuropathy. They can also be used as teaching materials for lecturers in relevant courses to improve students' preventive and rehabilitative skills. Future research is expected to implement interventions in a centralized location to increase efficiency, as well as examine the same variables in combination with

other therapies, such as *range of motion,* in order to enrich scientific evidence and provide more comprehensive intervention alternatives.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The final stage involved analyzing the data and compiling a research report. This research has been declared to have passed the ethical review of the health research ethics committee of Muhammadiyah Kudus University with number 276/Z-7/KEPK/UMKU/III/2025. On March 25, 2025.

ACKNOWLEDGMENTS

The researcher would like to express her deepest gratitude to Universitas Muhammadiyah Kudus for providing research permits, as well as to the National Unity and Politics Agency and the Kudus Regency Health Office for permitting this research. The researcher also expressed her appreciation to the Undaan Community Health Center and Medini Village for their assistance in providing facilities and infrastructure, as well as the respondents' readiness for the research.

REFERENCES

Adyas, A., Putri, D. U. P., Setiaji, B., & Sutriyani, S. (2022). Faktor–Faktor yang Mempengaruhi Penderita Diabetes Mellitus Peserta Posyandu Lansia. *Jurnal Ilmu Kesehatan Indonesia (JIKSI)*, *2*(2), 54–66. https://doi.org/10.57084/jiksi.v2i2.654

Agustini, N. L. P. I. B., Wangi, N. L. P. A. P., Megayanti, S. D., & Yusniawati, Y. N. P. (2025). *Manajemen Diabetes Berbasis Self Care*. https://repository.nuansafajarcemerlang.com/publications/591582/manajemen-diabetes-berbasis-self-care

Agustini, N. L. P. I. B., Wulansari, N. T., Yusniawati, Y. N. P., & Sintia, N. W. (2022). *The Effect of Foot Massage on Decreasing Peripheral Neuropathy Diabetic Complaints in the patients withe Type 2 Diabetes Mellitus*. *Malaysian Journal of Medicine and Health Sciences*, *18*(S17), 354–362.

Arania, R., Triwahyuni, T., Esfandiari, F., & Nugraha, F. R. (2023). Hubungan Antara Usia, Jenis Kelamin, dan Tingkat Pendidikan dengan Kejadian Diabetes Mellitus Di Klinik Mardi Waluyo Lampung Tengah. *Journal of Economics/ Zeitschrift Fur Nationalokonomie*, *139*(3), 235–260. https://doi.org/10.1007/s00712-023-00827-w

Arania, R., Triwahyuni, T., Prasetya, T., & Cahyani, S. D. (2021). Hubungan Antara Pekerjaan Dan Aktivitas Fisik Dengan Kejadian Diabetes Mellitus Di Klinik Mardi Waluyo Kabupaten Lampung Tengah. *Jurnal Medika Malahayati*, *5*(3), 163–169. https://doi.org/10.33024/jmm.v5i3.4110

Ayu, A. P., Wijayanti, I. G. A. S. P. W., & Mas'adah. (2024). *Pengaruh Training Foot Care Terhadap Kejadian Ulkus Kaki Diabetik Pada Pasien Diabetes Melitus*. *Indonesian Health Issue*, *3*(1), 44–59. https://doi.org/10.47134/inhis.v3i1.59

Berbudi, A., Rahmadika, N., Tjahjadi, A. I., & Ruslami, R. (2019). *Type 2 Diabetes and its Impact on the Immune System*. *Current Diabetes Reviews*,

16(5), 442–449. https://doi.org/10.2174/1573399815666191024085838

Chatchawan, U., Jarasrungsichol, K., & Yamauchi, J. (2020). *Immediate Effects of Self-Thai Foot Massage on Skin Blood Flow, Skin Temperature, and Range of Motion of the Foot and Ankle in Type 2 Diabetic Patients*. *Journal of Alternative and Complementary Medicine*, *26*(6), 491–500. https://doi.org/10.1089/acm.2019.0328

CLWK, B. C. P. N. S. & W. C. (2022). *Monofilament Testing for Loss of Protective Sensation (LOPS): Procedure*. *South West Regional Wound Care Program*, *March*, 1–5.

Darmawan, E. S., Permanasari, V. Y., Nisrina, L. V., Kusuma, D., Hasibuan, S. R., & Widyasanti, N. (2024). *Behind the Hospital Ward: In-Hospital Mortality of Type 2 Diabetes Mellitus Patients in Indonesia (Analysis of National Health Insurance Claim Sample Data)*. *International Journal of Environmental Research and Public Health*, *21*(5). https://doi.org/10.3390/ijerph21050581

Dinas Kesehatan Jawa Tengah. (2023). *Profil Jawa Tengah Tahun 2023*.

Dinas Kesehatan Kudus. (2023). *Profil Kesehatan Kabupaten Kudus*.

Ekavito, R. R. S., & Rakhmawati, A. (2023). *Pengaruh Foot Manual Massage terhadap Peningkatan Sensitivitas Kaki Pasien Diabetes Melitus di Klinik Pratama Balai Pengobatan Jatibening*. *MAHESA: Malahayati Health Student Journal*, *3*(9), 2619–2632. https://doi.org/10.33024/mahesa.v3i9.10879

Eppang, M., & Prabawati, D. (2020). *Efektivitas Massage Effleurage Terhadap Sensasi Proteksi Kaki Pada Pasien Diabetes Mellitus*. *Kaos GL Dergisi*, *8*(75), 147–154. https://doi.org/10.1016/j.jnc.2020.125798%0Ahttps://doi.org/10.1016/j.smr.2020.02.002%0Ahttp://www.ncbi.nlm.nih.gov/pubmed/810049%0Ahttp://doi.wiley.com/10.1002/anie.197505391%0Ahttp://www.sciencedirect.com/science/article/pii/B9780857090409500205%0Ahttp:

Faizal, N. F., Nurul Ulfah Mutthalib, & Farihah Muhsanah. (2024). Faktor Risiko Kejadian Penyakit Diabetes Melitus Di Wilayah Kerja Puskesmas Segeri Kabupaten Pangkep. *Window of Public Health Journal*, *5*(6), 899–913. https://doi.org/10.33096/woph.v5i6.2036

Fanani, A., & Sulaiman, L. (2021). *Faktor Obesitas dan Faktor Keturunan Dengan Kejadian Kasus Diabetes Mellitus*. *Riset Informasi Kesehatan*, *10*(1), 74. https://doi.org/10.30644/rik.v10i1.464

Fatmawati, Anggriani, Y., Mutiara, R., & Utami, H. (2021). *Evaluasi Profil Pengobatan Dan Biaya Penggunaan Insulin Manusia Dan Analog Pada Pasien Rawat Jalan Diabetes Melitus Tipe 2 Di Rsupn Dr. Ciptomangunkusumo*. *Jurnal Ilmiah Indonesia*, *6*(2), 1838–1854.

Firman, F., & Lestari, K. (2024). Jurnal Ekonomi Kesehatan Indonesia Analisis Pembiayaan berdasarkan Lama Rawat Pasien BPJS Diabetes Melitus Tipe II Komplikasi Sirkulasi Perifer di RSU PKU Muhammadiyah Bantul. *October*. https://doi.org/10.7454/eki.v9i1.1119

Hastuti, M. (2020). *Efektifitas Terapi Spa Kaki Dalam Menurunkan Keluhan Neuropati Diabetik Pada Pasien Diabetes Mellitus*. *Jurnal Maternitas Kebidanan*, *5*(2), 11–20. https://doi.org/10.34012/jumkep.v5i2.1255

Hidayad, R. (2025). *Determinan Sosial Kejadian Diabetes Melitus Tipe 2 Di Wilayah Kerja Puskesmas Pijorkoling Kota Padangsidimpuan Tahun 2024*. https://repository.unar.ac.id/jspui/handle/123456789/10032

Hijriana, I., & Miniharianti, M. (2022). *Foot Massage dan Joint Mobility Exercises terhadap Nilai Ankle Brachial Index (ABI) pada Pasien DM Tipe 2*. *Jurnal Keperawatan Silampari*, *5*(2), 650–658. https://doi.org/10.31539/jks.v5i2.3100

Hossain, M. J., Al-Mamun, M., & Islam, M. R. (2024). *Diabetes mellitus, the fastest growing global public health concern: Early detection should be focused*. *Health Science Reports*, *7*(3), 5–9. https://doi.org/10.1002/hsr2.2004

Ibrahim, I., Sofiani, Y., & Irawati, D. (2020). *Perbandingan Buerger Allen Exercise Dengan Foot Spa Diabetic Terhadap Nilai Ankle Brachial Index Pada Pasien Diabetes Melitus Tipe Ii*. *Journal of Islamic Nursing*, *5*(2), 86. https://doi.org/10.24252/join.v5i1.13673

International Diabetes Federation. (2023). *International Diabetes Federation*. www.cpcb.nic.in

Irayani, S. P. (2024). Hubungan Riwayat Keluarga, Aktivitas Fisik, dan Pola Makan terhadap Kejadian Diabetes Melitus. *Journal of Public Health Education*, *3*(4), 145–152. https://doi.org/10.53801/jphe.v3i4.227

Kurnia, A. D., Masruroh, N. L., Melizza, N., Prasetyo, Y. B., & Setyowati, C. I. (2022). *Efektifitas Perawatan Kaki Terhadap Gejala Neuropati Perifer Pada Penderita Diabetes Mellitus Dengan Michigan Neurophaty Screning Instrument*. *Malahayati Nursing Journal*, *4*(6), 1426–1434. https://doi.org/10.33024/mnj.v4i6.6468

Latipah, S., & Apriyanti, F. (2022). *Pengaruh Foot Self-Care Terhadap Neuropati Perifer Pada Pasien DM Tipe 2 Dengan Pendekatan Teori Keperawatan Orem*. *Prosiding Simposium Nasional Multidisiplin*, *4*, 1–5. https://jurnal.umt.ac.id/index.php/senamu/article/view/7664

Lim, P. C., Rajah, R., Lee, C. Y., Wong, T. Y., Tan, S. S. A., & Karim, S. A. (2021). *Systematic Review and Meta-Analysis of Diabetes Knowledge among Type 2 Diabetes Patients in Southeast Asia*. *Review of Diabetic Studies*, *17*(2), 82–89. https://doi.org/10.1900/RDS.2021.17.82

Lubis, S. A. M., Aminah, T. N. F., Pangestuty, S., Atika, R., Sembiring, S. P., & Aidha, Z. (2023). Faktor-Faktor yang Berhubungan dengan Kejadian Diabetes Melitus (DM) di Desa Kubah Sentang Kecamatan Pantai Labu. *Jurnal Ilmiah Universitas Batanghari Jambi*, *23*(2), 2061. https://doi.org/10.33087/jiubj.v23i2.2968

Mas Ulfa, N., Fandinata, S., & Puspitasari, I. (2023). *Analisis Efektifitas Biaya Terapi Pengobatan Pasien Diabetes Mellitus Tipe 2 terhadap Kontrol Glukosa Darah Cost Effectiveness*

Analysis of Treatment of Type 2 Diabetes Mellitus Patients on Blood Glucose Control. *Junal Kefarmasian Indonesia*, *13*(1), 83–94. https://doi.org./10.22

Milita, F., Handayani, S., & Setiaji, B. (2021). Kejadian Diabetes Mellitus Tipe II pada Lanjut Usia di Indonesia (Analisis Riskesdas 2018). *Jurnal Kedokteran Dan Kesehatan*, *17*(1), 9. https://doi.org/10.24853/jkk.17.1.9-20

Mulia, A. (2019). *Pengaruh Foot MassageTerhadap Kualitas Tidur Pada Pasien CHF (Congestive Heart Failure) Di Ruang HCU Cempaka 2 RSUD Dr. Adnaan WD Payakumbuh*. 1–23.

Novita, A., Hutahaean, R. E., Tanjung, R., Kep, S., Kep, M., & Kom, S. (2023). *Pengaruh Pijat Refleksi Kaki Pada Terhadap Neuropati Pada Penderita Diabetes Mellitus Abstrak Kata Kunci : Diabetes Mellitus , Pijat Refleksi , Neuropati Diabetik. Jurnal JKH*, *3*(1), 1–12.

Nurjannah, N., Saputra, B., & Erianti, S. (2023). Gambaran derajat keparahan neuropati perifer pada pasien diabetes melitus tipe 2. *Jurnal Prima Medika Sains*, *5*(1), 16–20. https://doi.org/10.34012/jpms.v5i1.3562

Oktavia, S., Budiarti, E., Marsa, F., Rahayu, D., & Setiaji, B. (2024). Faktor-Faktor Sosial Demografi Yang Berhubungan Dengan Kejadian Diabetes Melitus Tipe 2. *Jurnal Ilmiah Permas: Jurnal Ilmiah STIKES Kendal*, *14*(3), 75–82. https://journal2.stikeskendal.ac.id/index.php/PSKM/article/view/1979/1260

Paisal, A. (2021). Gambaran Self Care Pada Penderita Diabetes Mellitus Menurut Teori Orem. *Jurnal Penelitian Keperawatan*, 50–70.

Prabowo, M. H., Febrinasari, R. P., Pamungkasari, E. P., Mahendradhata, Y., Pulkki-Brännström, A. M., & Probandari, A. (2023). *Health-related Quality of Life of Patients With Diabetes Mellitus Measured With the Bahasa Indonesia Version of EQ-5D in Primary Care Settings in Indonesia*. *Journal of Preventive Medicine and Public Health*, *56*(5), 467–474. https://doi.org/10.3961/jpmph.23.229

Rasyid, A. N., Yulanda, N. A., & Fauzan, S. (2020). Perawatan Kaki Terhadap Perubahan Uji Sensitivitas Kaki Pada Penderita Dm Tipe 2. *Tanjungpura Journal of Nursing Practice and Education*, *2*(1). https://doi.org/10.26418/tjnpe.v2i1.41834

Ren, L., Guo, R., Fu, G., Zhang, J., & Wang, Q. (2022). *The efficacy and safety of massage adjuvant therapy in the treatment of diabetic peripheral neuropathy: A protocol for systematic review and meta-analysis of randomized controlled trials*. *Medicine (United States)*, *101*(10), E29032. https://doi.org/10.1097/MD.0000000000029032

Ritonga, S. H., Rahmadani, I., & Rambe, M. A. E. (2022). Gaya Hidup Penderita Diabetes Melitus Dengan Neuropati Perifer: Studi Fenomenologi. *Jurnal Kesehatan Ilmiah Indonesia (Indonesian Health Scientific Journal)*, *7*(2), 204–210. https://doi.org/10.51933/health.v7i2.936

Saprianto, S., Sujati, N. K., Supangat, S., & Akbar, M. A. (2022). *Efektivitas Edukasi Perawatan Kaki*

Melalui Edu Home Care Terhadap Kemampuan Perawatan Kaki Klien Diabetes Melitus. *JKM : Jurnal Keperawatan Merdeka*, *2*(2), 209–215. https://doi.org/10.36086/jkm.v2i2.1378

Saputri, R. D. (2020). *Komplikasi Sistemik Pada Pasien Diabetes Melitus Tipe 2*. *Jurnal Ilmiah Kesehatan Sandi Husada*, *11*(1), 230–236. https://doi.org/10.35816/jiskh.v11i1.254

Sim, A. S., Wijaya, D. A., Nathaniel, F., Yogie, G. S., Firmansyah, Y., Sugiarto, H., Amadea, S., & Santoso, A. H. (2023). *Profil Neuropati Perifer dan Korelasinya dengan Kadar Gula Darah Sewaktu di Panti Lansia Santa Anna*. *Malahayati Nursing Journal*, *5*(9), 3240–3250. https://doi.org/10.33024/mnj.v5i9.11121

Sinurat, N. A., Rahman, Z., Nirnasari, M., & Sintindaon, S. H. (2025). Pengaruh Foot Self Care dengan Kejadian Neuropati Perifer pada Pasien Diabetes Mellitus di RSUD Palmatak. *Jurnal Keperawatan STIkes Hang Tuah Tanjungpinang …*, *15*(1), 48–54. https://www.academia.edu/download/108255890/157.pdf

Siregar, E. (2021). *Faktor-Faktor Penyebab Kejadian Neuropathy Perifer Pada Penderita Diabetes Melitus Tipe 2 Di Wilayah Kerja Puskesmas Padang Matinggi Di Kota Padangsidimpuan Tahun 2021*.

Sitorus1, F. B. M., Waruwu, A. F. S., Ndraha, F. J., Mendrofa, P. T., & Melyany, F. B. (2023). Screening Gangguan Saraf Perifer Pada Pasien Diabetes Melitus Tipe II: Studi Deskriptif. *Jurnal Pustaka Keperawatan (Pusat Akses Kajian Keperawatan)*, *2*(2), 80–88. https://doi.org/10.55382/jurnalpustakakeperawatan.v2i2.687

Suharni, Diba Triulandari Kusnadi, & Zulkarnaini, A. (2022). Karakteristik faktor- faktor risiko terjadinya neuropati diabetik pada pasien diabetes melitus tipe 2 di RSI Siti Rahmah Padang Tahun 2019-2020. *Scientific Journal*, *1*(2), 94–100. https://doi.org/10.56260/sciena.v1i2.38

Survei Kesehatan Indonesia. (2023). Survei Kesehatan Indonesia (SKI). In *Kota Kediri Dalam Angka*.

Taher M. Al-Fahham, M. S. N., & Mohammed B. Al-Jubouri, P. (2024). Effectiveness of Foot Massage and Range of Motion Exercise on Diabetic Patients'' Peripheral Neuropathy: A Randomized Controlled Trial</i>. *1*(37), 50–64.

Tofure, I. R., Huwae, L. B., & Astuty, E. (2021). Karakteristik Pasien Penderita Neuropati Perifer Diabetik Di Poliklinik Saraf RSUD Dr. M. Haulussy Ambon Tahun 2016-2019. *Molucca Medica*, *14*(Dm), 97–108. https://doi.org/10.30598/molmed.2021.v14.i2.97

Trias Wari, A., Muhlishoh, A., Nurzihan, N. C., Studi, P., Program Sarjana, G., Kesehatan, I., Kusuma, U., Surakarta, H., & Jaya Wijaya, J. (2022). *Hubungan Indeks Glikemik Dan Beban Glikemik Makanan Terhadap Kadar LDL Dan RLPP Pasien Diabetes Mellitus Tipe-2*. *Universitas Kusuma Husada Surakarta*.

Wardani, E. M., & Nugroho, R. F. (2019). Spa Kaki Diabetik Sebagai Solusi Mencegah Amputasi. *Sustainability (Switzerland)*, *11*(1), 1–14. http://scioteca.caf.com/bitstream/handle/123456789/1091/RED2017-Eng-8ene.pdf?sequence=12&isAllowed=y%0Ahttp://dx.doi.org/10.1016/j.r

egsciurbeco.2008.06.005%0Ahttps://www.researchgate.net/publication/305320484_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI

Waruwu, M. I. S., & Afnijar Wahyu. (2024). Hubungan Lama Menderita Dengan Kejadian Neuropati Perifer Diabetik Pada Wanita Usia Produktif Di Wilayah Kerja Puskesmas Sering Medan. *Excellent Midwifery Journal*, *volume 6 n*(2), 103–108.

Zhu, J., Hu, Z., Luo, Y., Liu, Y., Luo, W., Du, X., Luo1, Z., Hu, J., & Peng, S. (2024). *Diabetic peripheral neuropathy: pathogenetic mechanisms and treatment*. *Frontiers in Endocrinology*, *14*(January), 1–17. https://doi.org/10.3389/fendo.2023.1265372.