Lentera Perawat
Volume 7 Number 1 : January-March 2026

OPEN ACCESS

Original Article

The effect of virgin coconut oil foot massage on peripheral neuropathy in type 2 diabetes: A pre-experimental study

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Keyword:
Diabetes Mellitus;
Foot Massage;
Peripheral Neuropathy;
Virgin Coconut Oil;

DOI:
https://doi.org/10.52235/lp.v7i1.636

Article Info:
Received : November 11, 2025
Revised : December 01, 2025
Accepted : January 29, 2026

Lentera Perawat
e-ISSN : 2830-1846
p-ISSN : 2722-2837

Abstract

Background: Diabetes mellitus is a chronic metabolic disorder characterized by elevated blood glucose levels that can lead to diabetic peripheral neuropathy, presenting with pain, numbness, and foot ulcers. Foot massage therapy using Virgin Coconut Oil (VCO) may improve blood circulation, enhance nerve function, and support skin health due to its lauric and oleic acid content.
Objective: This study aimed to examine the effect of foot massage therapy using virgin coconut oil on peripheral neuropathy scores among patients with type 2 diabetes mellitus.
Methods: A pre-experimental one-group pretest–posttest design was conducted involving 30 patients with T2DM and peripheral neuropathy recruited through purposive sampling at a primary healthcare center. Peripheral neuropathy was assessed using the 10 g Semmes–Weinstein Monofilament Test before and after the intervention. Participants received three sessions of standardized foot massage using virgin coconut oil, each lasting 30 minutes. Data were analyzed using the Wilcoxon signed-rank test with a significance level of $p < 0.05$.
Results: Data from 30 participants were analyzed. The median peripheral neuropathy score significantly decreased from 6.00 ± 2.18 before the intervention to 2.00 ± 1.46 after the intervention ($Z = -4.83$, $p < 0.001$). The calculated effect size ($r = 0.88$) indicated a large and clinically meaningful effect, reflecting an improvement from moderate to mild neuropathy severity.
Conclusion: Foot massage therapy using virgin coconut oil significantly reduced peripheral neuropathy severity in patients with type 2 diabetes mellitus. This intervention is safe, low-cost, and well tolerated, and it may serve as an effective complementary therapy for diabetic peripheral neuropathy management, particularly in low-resource settings.

Background

Diabetes mellitus (DM) is a chronic metabolic disorder marked by persistent hyperglycemia resulting from impaired insulin secretion, insulin resistance, or both, leading to complications such as neuropathy, nephropathy, and retinopathy (Febrinasari et al., 2020; Mezil & Abed, 2021). Globally, type 2 diabetes affected 537 million adults in 2023 and is projected to reach 783 million by 2045 (Atlas, 2015). In Indonesia, prevalence increased from 6.9% in 2013 to 8.5% in 2018, with an estimated 14.1 million cases by 2030 (Riskesdas, 2018). The 2023 Indonesian Health Survey reported 877,531 cases, predominantly type 2 diabetes (RI, 2024). In South Sumatra, 434,461 cases were recorded in 2022, with Palembang reporting the highest incidence, indicating a significant regional public health concern (Diskominfo, 2022).

Diabetic peripheral neuropathy (DPN) is a major diabetes complication characterized by peripheral nerve damage that causes sensory loss and increases the risk of ulcers, infections, and amputation (Boulton et al., 2005). Prolonged hyperglycemia drives DPN through oxidative stress, inflammation, and microvascular injury, resulting in impaired nerve signaling and repair (Baum et al., 2021). Early detection is essential, and the ADA recommends routine screening using tools such as the 10 g Semmes–Weinstein Monofilament Test, the gold standard for assessing sensory loss (Feldman et al., 2017; Sanklapur et al., 2020). Diabetes management involves education, diet, physical activity, medication, and glucose monitoring (Association, 2019). Pharmacotherapy alone often provides limited symptom relief. This has increased interest in non-pharmacological interventions such as foot massage, which may enhance circulation, stimulate nerve function, and reduce discomfort (Hutahaean & Novita, 2022). Supporting this, Chatchawan et al. (2015) found that a 2-week Thai foot massage improved balance, foot

sensation, and ankle–foot range of motion in patients with type 2 diabetes and neuropathy.

Virgin Coconut Oil (VCO) has demonstrated notable dermatological benefits, including enhanced wound healing, improved skin barrier function, and increased collagen synthesis, which support faster re-epithelialization (Arman et al., 2024; Nevin & Rajamohan, 2010). Its anti-inflammatory, antioxidant, and antibacterial properties further contribute to reducing inflammation and protecting the skin. Although no clinical trials have specifically evaluated VCO as a massage medium for diabetic peripheral neuropathy, its moisturizing effect and ability to improve skin integrity make it suitable for use during foot massage to optimize skin contact and minimize irritation. Evidence also shows that VCO significantly improves skin hydration and lipid content compared with mineral oil (Agero & Verallo-Rowell, 2004; Zamroni et al., 2023), and has been utilized in diabetic foot care to alleviate xerosis and pruritus (Zuryati, 2018). Additionally, VCO exhibits antibacterial activity against skin pathogens such as Staphylococcus aureus by disrupting bacterial cell walls and enhancing immune cell phagocytic activity, supporting its relevance in foot care for individuals with chronic conditions, including diabetes (Widianingrum et al., 2019).

VCO also exhibits anti-inflammatory and skin-protective activities, as shown in human cell studies where it reduced pro-inflammatory cytokines such as TNF-α and IL-6 while upregulating skin-protective proteins, thereby enhancing barrier function (Varma et al., 2019). In parallel, growing evidence supports manual therapies as complementary approaches for diabetic peripheral neuropathy (DPN). A systematic review protocol by Ren et al. (2022) highlighted the need to evaluate massage therapy through randomized controlled trials to determine its effects on pain, nerve function, and quality of life, reflecting increasing scientific interest in integrating non-pharmacological interventions into comprehensive DPN management.(Ren et al., 2022)

The novelty of using Virgin Coconut Oil (VCO) as a massage lubricant lies in its distinct biochemical composition, particularly its medium-chain fatty acids such as lauric and capric acid, which exhibit anti-inflammatory, antioxidant, and potential neuroprotective effects. These bioactive compounds may enhance peripheral nerve function by reducing local inflammation, improving microcirculation, and strengthening the skin barrier. When combined with foot massage, VCO may offer synergistic therapeutic benefits beyond those of conventional oils.

However, previous studies did not specifically evaluate diabetic peripheral neuropathy using standardized tools such as the Semmes–Weinstein Monofilament Test or the Michigan Neuropathy Screening Instrument. Consequently, evidence on the effects of foot massage combined with VCO on neuropathy outcomes in type 2 diabetes remains limited. This study addresses this gap by examining the impact of VCO-assisted foot massage on peripheral neuropathy in patients with type 2 diabetes mellitus.

Methods

Study Design

This study employed a pre-experimental one-group pretest–posttest design to evaluate the effect of foot massage therapy using Virgin Coconut Oil (VCO) on peripheral neuropathy scores among patients with Type 2 Diabetes Mellitus. In this design, all participants received the same intervention, and outcome measurements were conducted before and after the therapy to assess changes in neuropathy status.

The pre-experimental approach was chosen because it allows for the direct observation of the intervention's effect within a single group, particularly in clinical settings where a control group may be impractical, resource-limited, or ethically constrained. This design is also appropriate for exploratory studies aimed at generating preliminary clinical evidence. However, the one-group pretest–posttest structure carries inherent threats to internal validity that must be acknowledged. Potential risks include maturation (natural symptom changes over time unrelated to the intervention), history effects (external factors occurring between pretest and posttest that may influence outcomes), and the placebo effect (improvement due to patient expectations rather than the therapeutic action). Recognizing

these limitations is essential to accurately interpret the findings and to justify the need for more rigorous controlled studies in the future.

All participants were screened for peripheral arterial disease, severe edema, and risk of diabetic foot ulcers prior to the intervention to ensure safety and minimize potential adverse events. Additionally, participants' medication regimens, including the use of antidiabetic agents (e.g., metformin, insulin) and neurotrophic vitamins or supplements, were recorded at baseline, as these medications may influence neuropathy progression and response to intervention. Participants were instructed to continue their usual medications throughout the study, and any changes during the intervention period were documented.

Sampling

Participants were recruited using a purposive sampling technique, which enabled the deliberate selection of individuals who met criteria directly aligned with the study objectives. Purposive sampling was theoretically justified because peripheral neuropathy in Type 2 Diabetes Mellitus requires participants with specific clinical characteristics to ensure that the intervention is tested on an appropriate target population. However, the use of this non-probability sampling method may introduce selection bias, and the findings may have limited generalizability beyond similar clinical settings. These considerations were acknowledged as part of the study's methodological limitations.

The study population consisted of 68 individuals with Type 2 Diabetes Mellitus aged over 25 years, registered at a primary healthcare center in January 2025. The required sample size was determined using the Slovin formula with a 15% margin of error, which indicated a minimum of approximately 27 participants. To anticipate an estimated 10% dropout rate, the final target sample size was increased to 31 participants, all of whom completed the study.

Eligible participants were adults aged 25 to 59 years, medically diagnosed with Type 2 Diabetes Mellitus, and exhibiting sensory disturbances consistent with peripheral neuropathy, confirmed using the 10 g Semmes–Weinstein Monofilament Test. Additional inclusion criteria included the ability to communicate effectively, willingness to participate, and the absence of severe comorbidities such as cardiovascular disease, diabetic foot ulcers, or active infections. All participants were informed about the study purpose, procedures, potential risks, and benefits. Written informed consent was obtained before enrollment. Individuals who did not meet the inclusion criteria or withdrew before completing the intervention were excluded from the analysis.

Instruments

Peripheral sensory function was assessed using the 10 g Semmes Weinstein Monofilament Test following standard clinical guidelines. Sensation was tested at the recommended sites on the plantar surface of each foot. A site was considered insensate when the participant failed to perceive the filament after at least one of three applications, which is consistent with established diagnostic criteria for peripheral neuropathy. The presence of ≥1 insensate site was interpreted as reduced protective sensation, indicating peripheral neuropathy. The 10 g monofilament has been widely validated as a reliable screening tool, demonstrating good sensitivity and specificity for detecting loss of protective sensation in individuals with diabetes (e.g., Armstrong et al., 1998; Feng et al., 2009).

Intervention

The foot massage intervention was administered individually to each participant following a standardized protocol to ensure consistency and reproducibility. All sessions were conducted in a controlled environment with adequate lighting, minimal noise, and room temperature maintained within a comfortable range of 25-27°C to support participant relaxation. Approximately 10 mL of Virgin Coconut Oil (VCO) was gently warmed to skin temperature before application. The massage was performed using light to moderate pressure (approximately 3–5 kg) with a consistent rhythm of 40–60 strokes per minute,

incorporating effleurage, petrissage, and circular friction techniques. Massage was applied to the plantar and dorsal surfaces of the feet, the ankle region, and the lower calf, following peripheral circulation pathways.

Each session lasted 30 minutes (15 minutes per foot) and was delivered by trained personnel to ensure adherence to the protocol and standard massage safety guidelines (Vickers et al., 2001). Participants were placed in a comfortable sitting or reclining position throughout the procedure. Continuous monitoring was conducted to identify potential adverse events, including skin irritation, discomfort, exacerbation of neuropathic pain, or allergic reactions to VCO. Participants were encouraged to report any unusual sensations or concerns immediately. No adverse events were observed or reported during the intervention period.

The intervention consisted of three sessions per participant, which, although relatively brief compared with long-term therapeutic protocols, was intentionally selected to evaluate short-term feasibility and immediate effects of foot massage on peripheral circulation, sensory responsiveness, and relaxation. Previous studies on foot massage in patients with diabetic peripheral neuropathy have shown that structured interventions can produce measurable improvements in foot sensation, balance, mobility, and neuropathic symptoms. For instance, (Chatchawan et al., 2015) demonstrated that Thai foot massage conducted three times per week for two weeks significantly improved balance, range of motion, and plantar sensitivity in patients with diabetic peripheral neuropathy. Similarly, (Taher M. Al-Fahham & Mohammed Baqer Al-Jubouri, 2023) reported that foot massage over a short-term intervention period reduced neuropathy scores significantly compared to control. These findings support that even a limited number of sessions can yield short-term beneficial effects, providing preliminary evidence of effectiveness, while acknowledging that further studies with extended sessions or follow-up assessments are required to evaluate sustained long-term impact.

The procedure was designed to promote peripheral circulation, enhance sensory responsiveness, and support overall relaxation.It should be noted that this study did not include structured patient education or home-based self-massage training as part of the intervention. Participants were instructed to continue their usual daily routines and prescribed medications. While the short-term effects of foot massage were assessed, the absence of home-based training may limit the sustainability of these benefits. Future studies could incorporate patient education and self-administered foot massage to enhance continuity of care and potentially improve long-term outcomes.

Data Collection

Data collection was carried out in two phases: pretest and posttest. Before the intervention, participants baseline peripheral neuropathy status was assessed using the 10 g Semmes-Weinstein Monofilament Test (SWMT), which served as the pretest neuropathy score. After completing three sessions of foot massage therapy with Virgin Coconut Oil (VCO), the same assessment procedure was administered to obtain posttest scores. All neuropathy measurements were conducted by a single trained researcher to ensure procedural consistency and minimize inter-observer bias. Sociodemographic data including age, sex, duration of diabetes, and comorbid conditions were collected through structured interviews and verified using participants medical records. All collected data were documented on standardized data collection sheets and subsequently entered into IBM SPSS Statistics version 22.0 for analysis. Data quality assurance was maintained through double-entry verification and cross-checking procedures. Participant confidentiality was strictly preserved throughout the entire research process.

Data Analysis

Data were analyzed using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA). Data normality was assessed using the Shapiro-Wilk test, and differences between pretest and posttest neuropathy scores were

evaluated using the Wilcoxon signed-rank test. A p-value of < 0.05 was considered statistically significant.

Ethical Consideration

All participants received a clear explanation of the study objectives, procedures, potential risks, and anticipated benefits before recruitment. Participation was entirely voluntary, and each participant provided written informed consent before enrollment. Confidentiality and anonymity were strictly maintained by assigning identification codes instead of personal names in all data records. Participants were informed of their right to withdraw from the study at any time without any consequences for their medical care. All collected data were used exclusively for research purposes and stored securely with restricted access by the research team.

Results

Data analysis was conducted using both univariate and bivariate approaches. The univariate analysis described the respondents' characteristics, including demographic variables and baseline measurements, using frequency distributions, means, and standard deviations. The bivariate analysis examined the relationship between the intervention and changes in peripheral neuropathy scores before and after foot massage therapy using virgin coconut oil (VCO).

Table 1. Respondents Characteristics

Characteristics	n	%
Age		
Young adult (20-35 years)	1	3,3
Productive adult (36-50 years)	4	13,3
Late adult (51-59 years)	11	36,7
Elderly (≥60 years)	14	46,7
Gender		
Male	10	33,3
Female	20	66,7
Education		
Higher education	11	36,7
Lower education	19	63,3
Occupation		
Employed	8	26,7
Unemployed	22	73,3
Duration of Illnes		
≤6 month	2	6,7
>6 month- ≤5 years	4	13,3
>5 years	24	80,0

As shown in Table 1, the majority of respondents were elderly (46.7%) and female (66.7%). Most participants had a low level of education (63.3%) and were unemployed (73.3%). Furthermore, a large proportion had been living with type 2 diabetes mellitus for more than five years (80.0%).

Table 2 presents the distribution of peripheral neuropathy scores among patients with type 2 diabetes mellitus prior to foot massage therapy using virgin coconut oil (VCO). The median neuropathy score was 6.0 (SD = 2.18; range = 3-0), indicating that participants generally exhibited a moderate level of neuropathic impairment before the intervention.

Table 2 presents the distribution of peripheral neuropathy scores following foot massage therapy using virgin coconut oil (VCO) among patients with type 2 diabetes mellitus. The median post-intervention score was 2.00 (SD = 1.46; range = 0.00-5.00), demonstrating a marked improvement from baseline. These findings indicate a substantial reduction in neuropathic symptoms after the intervention, with most participants exhibiting mild or no residual sensory deficits. The observed

improvement suggests that foot massage therapy with VCO effectively enhanced peripheral nerve function, potentially through improved microcirculation, reduced oxidative stress, and the neuroprotective effects of its bioactive components.

The Wilcoxon Signed Ranks test showed a significant decrease in peripheral neuropathy scores after foot massage therapy using Virgin Coconut Oil (VCO) ($Z = -4.83$, $p < 0.001$). The median score decreased from 6.00 before the intervention to 2.00 after the therapy, indicating improvement in peripheral nerve function among patients with type 2 diabetes mellitus.

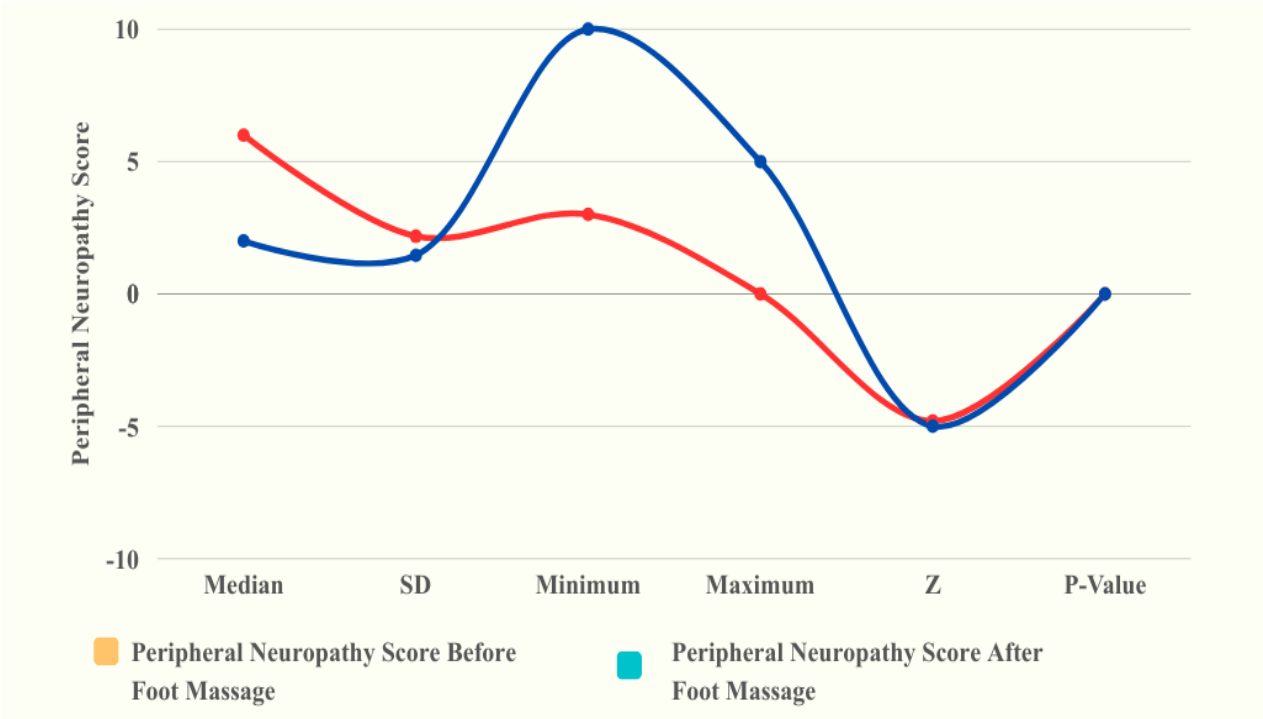
To evaluate the clinical significance, the effect size was calculated using the formula $r = Z / \sqrt{N}$. Based on the sample size ($N = 30$), the effect size was $r = 0.88$, indicating a large effect. This large effect size, combined with a median reduction of 4 points, suggests that foot massage therapy with VCO is not only statistically significant but also clinically meaningful in reducing the severity of peripheral neuropathy symptoms.

Table 2. Effect of Foot Massage Therapy Using Virgin Coconut Oil (VCO) on Peripheral Neuropathy Scores in Patients with Type 2 Diabetes Mellitus

Variables	n	Median	SD	Minimum	Maximum	z	p-value
Before Foot Massage	30	6.00	2.18	3.00	10.00	-4.83	0.000
After Foot Massage	30	2.00	1.46	0.00	5.00		

Figure 1 shows the effect of Virgin Coconut Oil (VCO) foot massage on peripheral neuropathy scores in patients with Type 2 Diabetes Mellitus (T2DM). Red pre-intervention scores; blue post-intervention scores. A significant reduction in neuropathy scores was observed after the intervention ($P < 0.05$), indicating improved peripheral nerve function. Descriptive and inferential statistics are shown on the x-axis (median, SD, minimum, maximum, Z-value, P-value).

Figure 1. Difference in Peripheral Neuropathy Scores Before and After Foot Massage Using Virgin Coconut Oil (VCO) in Patients with Type 2 Diabetes Mellitus



Discussion

The demographic analysis of this study revealed that most participants were elderly and had lived with type 2 diabetes mellitus (T2DM) for more than five years. This finding aligns with previous research indicating that both advancing age and longer disease duration are major determinants of diabetic peripheral neuropathy (DPN), as prolonged hyperglycemia promotes oxidative stress, vascular dysfunction, and neuronal injury over time (Hicks & Selvin, 2019). Age-related physiological changes, including reduced nerve regeneration capacity and impaired microcirculation, further exacerbate neuropathic progression in elderly individuals (Pope et al., 2015).

Participants with lower educational and income levels showed higher HbA1c values and greater diabetes-related distress, indicating poorer glycemic control and reduced self-management capacity (Silverstein et al., 2018). Unemployed patients were more likely to exhibit poor glycemic control and inadequate self-care behaviors compared with employed individuals (Ayele et al., 2012).

Most respondents had been diagnosed with diabetes for more than six months to five years, indicating a predominance of patients in the chronic phase of the disease. The duration of diabetes is an important factor influencing the occurrence and severity of diabetic peripheral neuropathy. Individuals with a longer duration of illness are more prone to nerve damage due to prolonged exposure to hyperglycemia and oxidative stress (Callaghan et al., 2012). Chronic hyperglycemia leads to microvascular complications and accumulation of advanced glycation end-products (AGEs), which impair nerve conduction and blood flow to peripheral nerves (Tesfaye et al., 2010)

The present study showed that patients with type 2 diabetes mellitus experienced a moderate level of peripheral neuropathy prior to the administration of foot massage therapy using virgin coconut oil (VCO). The median neuropathy score was 6.0, indicating that most participants had already developed noticeable sensory disturbances before the intervention. Peripheral neuropathy is one of the most common complications of diabetes and is primarily caused by chronic hyperglycemia, which leads to microvascular damage and progressive loss of peripheral nerve function. This pathophysiological mechanism has been clearly described (Tesfaye et al., 2010). Further emphasized that long-term metabolic stress contributes to axonal degeneration and reduced nerve conduction velocity, resulting in sensory and motor deficits (Callaghan et al., 2012).

The moderate neuropathic impairment found in this study is consistent with the findings of Inceu et al. (2024), who observed that more than half of patients with long-standing diabetes presented with moderate to severe neuropathic symptoms. (Inceu et al., 2024). A similar pattern was reported by Silva-Tinoco et al. (2020), who identified that limited education and low income levels were associated with higher neuropathy scores and poorer glycemic control. These results suggest that socioeconomic conditions may influence neuropathic progression through inadequate self-care and reduced access to treatment (Silva-Tinoco et al., 2020).

Overall, the findings of this study demonstrate that participants had established neuropathic impairment before receiving the intervention. This provides a strong baseline for assessing the therapeutic potential of foot massage therapy with VCO in improving peripheral nerve function and symptom reduction in patients with type 2 diabetes mellitus.

The present study demonstrated a significant reduction in peripheral neuropathy scores following foot massage therapy with virgin coconut oil (VCO) among patients with type 2 diabetes mellitus. This finding aligns with previous research indicating that foot massage can enhance microcirculation and improve sensory function in diabetic patients with peripheral neuropathy (Chatchawan et al., 2020). A randomized controlled trial also reported that Thai foot massage significantly improved foot sensation as measured by the Semmes–Weinstein Monofilament Test (SWMT) and increased balance performance in

individuals with diabetic neuropathy (Chatchawan et al., 2015).

Similarly, a systematic review of non-pharmacological therapies identified foot massage as an effective complementary intervention to reduce neuropathic symptoms and enhance peripheral nerve function (Cakici et al., 2016). The observed improvement in neuropathic symptoms in this study may be attributed to improved blood flow, enhanced oxygen delivery to nerve tissues, and reduced oxidative stress. Previous evidence has shown that stimulation through massage can modulate nitric oxide–mediated vasodilation, thereby increasing skin perfusion in patients with diabetes-related neuropathy (Chatchawan et al., 2020)

Furthermore, the use of virgin coconut oil may have amplified these benefits due to its rich content of medium-chain fatty acids and antioxidant compounds. A randomized clinical trial demonstrated that VCO consumption reduced oxidative stress biomarkers and elevated serum brain-derived neurotrophic factor (BDNF), which supports neuronal survival and repair (Mansouri et al., 2024).

Taken together, these results suggest that foot massage therapy with VCO offers a synergistic therapeutic effect by improving microcirculation and providing neuroprotective activity, leading to decreased neuropathic symptom severity in patients with type 2 diabetes mellitus

The results of this study showed a significant reduction in peripheral neuropathy scores following foot massage therapy with Virgin Coconut Oil (VCO) ($Z = -4.832$, $p < 0.001$). The median score decreased from 6.00 before the intervention to 2.00 after the therapy, indicating improved peripheral nerve function in patients with type 2 diabetes mellitus. This finding aligns with prior studies demonstrating that foot massage can improve sensory function, enhance peripheral circulation, and reduce neuropathic symptoms in diabetic patients (Agustini et al., 2019).

Similarly, Puryanti et al. (2023) reported that combining foot massage with foot exercise enhanced peripheral perfusion in patients with type 2 diabetes, supporting the physiological benefits of mechanical stimulation in promoting microvascular blood flow and nerve repair (Puryanti et al., 2023)Foot massage has also been found to improve nerve conduction and reduce neuropathic symptom severity in both traditional and modern therapeutic contexts, as demonstrated by systematic reviews of foot massage combined with acupoint therapy (Fu et al., 2020)

The use of VCO may further augment these effects due to its bioactive compounds, including medium-chain fatty acids and polyphenols, which possess antioxidant and anti-inflammatory properties (Saudah et al., 2021). Studies in Indonesia have shown that VCO can reduce blood glucose levels in diabetic populations and promote healing in diabetic ulcers through anti-inflammatory and antioxidative mechanisms (Suarni & Fitarina, 2019). These effects may reduce oxidative stress and inflammation in peripheral nerves, contributing to improved nerve function and symptom relief.

Taken together, the combination of foot massage and VCO application appears to provide a synergistic therapeutic effect: the mechanical stimulation from massage enhances microcirculation and nerve signaling, while VCO's neuroprotective and antioxidative properties support nerve repair. This approach offers a safe, non-pharmacological complementary intervention for managing peripheral neuropathy in type 2 diabetes mellitus patients, which could be especially beneficial in low-resource settings where access to advanced pharmacological treatments is limited.

This study has several limitations that should be considered. First, the intervention was not blinded, which may introduce measurement or expectation bias. Second, a placebo effect cannot be ruled out, as participants may have experienced improvements partly due to their anticipation of benefits from the foot massage. Third, the evaluation period was relatively short, limiting the ability to assess long-term effects of the intervention. In addition, baseline

metabolic parameters such as HbA1c were not measured; therefore, correlations between glycemic control and neuropathy severity could not be assessed. Future studies should include these measurements to better understand the metabolic contribution to neuropathy outcomes.

Conclusion and Recommendation

Foot massage therapy using Virgin Coconut Oil (VCO) significantly reduced peripheral neuropathy scores in patients with type 2 diabetes mellitus, indicating improved peripheral nerve function and symptom relief. This intervention was safe, well-tolerated, and has the potential to serve as an effective complementary non-pharmacological therapy for managing diabetic peripheral neuropathy.

Healthcare practitioners are encouraged to consider integrating VCO-based foot massage into routine care for patients with mild to moderate neuropathy. Clinical recommendations should emphasize multidisciplinary integration with dietitians, physiotherapists, and diabetic foot specialists to optimize patient outcomes, combining lifestyle modification, physical therapy, and neuropathy management strategies.

Future research should explore the long-term effects, optimal frequency, and duration of therapy, and potential synergistic benefits when combined with other interventions. Studies with larger sample sizes and objective assessments, such as nerve conduction studies, are warranted. Furthermore, including a control or comparison group, such as standard care, placebo massage, or alternative oil application, would enhance internal validity and strengthen causal inference by allowing clearer differentiation between the true therapeutic effects of VCO massage and placebo responses or natural symptom fluctuations.

Acknowledgment
The author would like to express deepest gratitude to all respondents who willingly took the time to participate in this research.

Funding Source
None

Declaration of conflict of interest
The authors declare no competing interests.

Declaration on the Use of AI
No AI tools were used in the preparation of this manuscript.

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