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# The effectiveness of foot exercises and trigona honey on type 2 DM neuropathy

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**ABSTRACT**

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder with a steadily increasing number of cases globally. The International Diabetes Federation (IDF) reported in 2021 that 10.5% of the global population, or approximately 537 million adults, live with diabetes, and this figure is projected to increase to 12.2%, equivalent to 783 million people, by 2045. One of the chronic complications often experienced by people with T2DM is diabetic neuropathy. This condition is characterized by decreased peripheral nerve function and increased pain intensity. Foot exercises are a non-pharmacological intervention that can increase blood flow, strengthen muscles, and stimulate peripheral nerves, potentially improving neuropathy symptoms. The purpose of this study was to analyze the effectiveness of foot exercises in reducing pain and increasing sensitivity in the feet of people with type 2 DM. The method used was a quasi-experimental pretest-posttest design. A sample of 30 respondents was divided into two groups. Data analysis used the Wilcoxon Signed Rank Test. The results showed a significant reduction in pain between the first and fourth weeks (p=0.014). Right foot sensitivity increased significantly in the first week (p=0.013), the second week (p=0.001), and the fourth week (p=0.008), while the left foot showed a significant increase in the first week (p=0.013). In conclusion, foot exercises are effective in reducing pain and increasing foot sensitivity in patients with type 2 diabetes.



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# INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder with a steadily increasing number of cases globally. The International Diabetes Federation (IDF) reported in 2021 that 10.5% of the global population, or approximately 537 million adults, are living with diabetes, and this number is expected toi increasei toi 12.2%, or 783 million people, by 2045 (Maglianoi DJ & Boykoi EJ, 2021). In Indonesia, a similar trend is also observed, with the prevalence of T2DM increasing from 6.9% in

2013 to 8.5% in 2018 (Resti & Cahyati, 2022). In West Nusa Tenggara (NTB) Province, the number of diabetes sufferers increased from 53,139 in 2019 to 63,488 in 2021 (Drs. Wahyudin, MM ; M. Ikhsany Rusyda, SST, 22 C.E.). Mataram City is one of the areas with a significant increase in cases, as seen in the Jempong Baru area, Karang Pule Community Health Center, which recorded an increase in the number of patients from 317 in 2019 to 1,150 in 2021(Riskawaty, 2023).

One of the chronic complications often experienced by people with type 2 diabetes mellitus (T2DM) is diabetic neuropathy, a condition that impacts quality of life and is associated with an increased risk of foot ulcers and amputations (Riskawaty, 2023); (Riskawaty et al., 2023); (Riskawaty, 2022). Approximately half of patients with type 2 diabetes (T2DM) experience peripheral neuropathy, but its management is still hampered by limited pharmacological therapy and long-term side effects, thus driving the need for safer and more sustainable non-pharmacological therapy options (Mawaddah Mawaddah & Dwi Widya Wati, 2024); (Yulianti & Januari, 2021); (Onta, 2024). One intervention that has been proven beneficial is foot exercise for people with diabetes. This exercise improves peripheral circulation, increases leg muscle strength, and helps reduce neuropathic pain through nerve stimulation and improved musculoskeletal function (Pratiwi, 2022).

In addition to physical exercise, functional nutrition approaches such as Trigona honey also show great potential as a complementary therapy for type 2 diabetes. The phenolic compounds, antioxidants, and anti-inflammatory properties in this honey play a role in protecting pancreatic beta cells, increasing insulin sensitivity, and reducing oxidative stress that contributes to diabetic neuropathy (Sahlan et al., 2019); (Syamsul, 2021); (Vekic et al., 2026).

However, although foot exercises and nutritional therapy have been shown to provide benefits separately, most previous studies have been limited to testing single interventions, thus failing to address the complexity of diabetic neuropathy involving simultaneous peripheral circulatory impairment and oxidative stress (Mawaddah Mawaddah & Dwi Widya Wati, 2024); (Khurshid et al., 2025); (Yulianti & Januari, 2021); (Onta, 2024); (Purwaningsih, 2023).

This gap underpins the novelty of this research, which combines leg exercises and Trigona honey in an integrated approach to explore the potential for under-researched synergistic effects, with the hope of achieving optimal improvement through improved circulation and nerve function while simultaneously reducing oxidative stress and inflammation. Furthermore, both interventions are simple, affordable, and easy to implement, offering high practical value for development in primary healthcare settings, where comprehensive non-pharmacological interventions are still limited (Gracia-Sánchez et al., 2025). Based on the above issues, research is needed to determine the effectiveness of foot exercises in reducing neuropathic pain and improving nerve function in people with type 2 diabetes.

# RESEARCH METHODE

This study applied a quasi-experimental design with a pretest–posttest control group approach. The study was conducted in the Karang Pule Community Health Center, Mataram City, and lasted for four weeks. The sample consisted of 30 respondents, divided into 15 people each in the intervention group and 15 people in the control group, selected through a purposive sampling technique based on inclusion criteria. The inclusion criteria included: Patients diagnosed with diabetic neuropathy, determined based on a Douleur Neuropathique 4 (DN4) score ≥ diagnostic threshold and a 10-gram monofilament test result indicating impaired sensation, aged 40–70 years, No severe comorbidities (end-stage renal failure, severe stroke, severe heart disease), willing to participate in the study until completion. The intervention group received foot exercises and Trigona honey for four weeks. The exercises were performed three times a week, lasting approximately 15–20 minutes each session, and 30 grams of Trigona honey was administered orally daily. Data were collected using a Visual Analog Scale (VAS) to measure the level of neuropathic pain, while peripheral nerve function was assessed through a 10-g monofilament

examination to assess sensory responses to light pressure. Data analysis was performed using a paired t-test and an independent t-test, using a significance level of $p < 0.05$.

# RESULTS AND DISCUSSION

**Tabel 1.** Distribution of respondents by gender

| Geindeir | F | % |
|---|---|---|
| Feimalei | 9 | 60.0 |
| Malei | 6 | 40.0 |
| Toital | 15 | 100 |

Based on the results of the research in the intervention group in table 1. frequency distribution of respondents based on gender, it can be seen that of the total of 15 respondents, the majority of respondents were female, namely 9 respondents (60.0%), while there were 6 male respondents (40.0%).

**Tabeil 2.** Distribution of respondents by gender

| Gender | F | % |
|---|---|---|
| Female | 11 | 73.3 |
| Male | 4 | 26.7 |
| Toital | 15 | 100 |

Based on the results of the study on the control group (leg exercises) in Table 2, the frequency distribution of respondents by gender shows that of the 15 respondents, the majority were female (11 respondents (73.3%), while 4 respondents were male (26.7%).

The results of this study show that women suffer more from Diabetes Mellitus than men (Samapati et al., 2023). These findings support previous research suggesting that women are at greater risk of experiencing decreased foot sensitivity due to the decline in estrogen during menopause. Estrogen plays a role in maintaining balanced blood sugar levels and increasing fat storage, while progesterone helps normalize blood sugar levels and utilize fat as an energy source (Nani et al., 2022).

**Tabel 3.** Distribution by age

| | N | Minimum | Maximum | Meian SD |
|---|---|---|---|---|
| Agei | 15 | 45 | 69 | 57.73 7.573 |
| Valid N (listwisei) | 15 | | | |

Based on the results of the research in the intervention group of respondents, when viewed from age, of the 15 participants, the maximum age was 69 years, the minimum age was 45 years with an average age of respondents of 57.73 years, and a standard deviation of 7,573

**Tabeil 4.** Distributioin by Agei

| | N | Minimum | Maximum | Meian SD |
|---|---|---|---|---|
| Agei | 15 | 45 | 67 | 56.13 5.502 |
| Valid N (listwisei) | 15 | | | |

Based on the results of the study in the control group (foot exercises), of the 15 respondents, the maximum age was 67 years, the minimum age was 45 years, with a mean age of 56.13 years, and a standard deviation of 5.502.

Research shows that aging significantly decreases the function of pancreatic beta cells, reducing their ability to produce insulin effectively (Komariah, 2020). According to Syamsul (2021), age over 30 is a risk factor for T2DM because it is associated with a decline in the body's

anatomical, physiological, and biochemical functions. Diabetes mellitus generally occurs more frequently in those aged 45 years and older, when the aging process begins to reduce beta cell capacity.

**Table 5.** Effectiveness of diabetic foot exercises on foot sensitivity in patients with type 2 diabetes mellitus in the Karang Pule Community Health Center, Mataram City

| | Foot sensitivity | Ties | Negative ran | Positiv Rank | P value |
|---|---|---|---|---|---|
| Week 1 | | | | | |
| Pre Test-Pos tes | Right Foot<br>Right Foot | 5 | 1 | 9 | 0.013 |
| Pre Test-post tes | Leift Foot<br>Left Foot | 5 | 9 | 1 | 0.013 |
| Week 2 | | | | | |
| Pre Test-Pos tes | Right Foot<br>Right Foot | 2 | 0 | 13 | 0.001 |
| Pre Test-post tes | Left Foot<br>Left Foot | 8 | 2 | 5 | 0.083 |
| Week 3 | | | | | |
| Pre Test-post tes | Right Foot<br>Right Foot | 8 | 1 | 6 | 0.053 |
| Pre Test-post tes | Left Foot<br>Left Foot | 6 | 6 | 3 | 0.248 |
| Week 4 | | | | | |
| Pre Test-post tes | Right Foot<br>Right Foot | 4 | 1 | 10 | 0.008 |
| Pre Test-post tes | Left Foot<br>Left Foot | 4 | 5 | 6 | 0.854 |

The study results indicate that diabetic foot exercise intervention significantly improved foot sensitivity in people with T2DM, particularly in the right foot. Based on the Wilcoxon Signed Rank Test, right foot sensitivity significantly improved in the first week ($p = 0.013$), the second week ($p = 0.001$), and the fourth week ($p = 0.008$), while the third week showed improvement ($p = 0.053$). Conversely, left foot sensitivity showed inconsistent improvement and was only significant in the first week ($p = 0.013$), while the second to fourth weeks showed no significant change ($p > 0.05$).

The improvement in foot sensitivity in this study suggests that diabetic foot exercise can stimulate peripheral nerve function, particularly in the lower extremities, which commonly experience neuropathy in people with T2DM. These exercises involve dorsiflexion, plantarflexion, inversion, and eversion movements, which can increase blood flow to the foot's nerve tissue and improve nerve conduction. This mechanism aligns with the theory that peripheral muscle activity can improve neurovascular coupling, the relationship between blood perfusion and nerve activity, thus improving sensation and neurological responses (Rodica et al., 2017).

These findings align with research by Inayah, 2023 and Mustika et al., 2022, which reported that consistent diabetic foot exercises for four weeks improved peripheral nerve function and foot sensitivity in people with diabetc neuropathy. Another study by Purwaningsih et al., 2023 also showed similar results, where type 2 diabetes patients who performed foot exercises two to three times a week experienced improved vibration and tactile sensation compared to the control group.

The more consistent improvement in sensitivity in the right foot may be due to the dominant use of the right foot in daily activities. Dominance of a particular side of the body can provide a more optimal training effect on the more functionally active side. According to (Nur, Hasrul, 2021), the dominant limb generally has a better neuromuscular response than the non-dominant side, thus the training effects can be more significant.

Fluctuations in the results in the left foot may also be due to differing degrees of neuropathy among respondents. In some cases, one foot may experience more severe neuropathy

than the other. Studies by (Tesfayei et al., 2010); (Gracia-Sáncheiz eit al., 2025) report that diabetic neuropathy is not always symmetrical, and the progression of nervei damagei can differ between the left and right feet, thus varying responses to physical interventions.

A four-week intervention appears to have a significant impact on peripheral nervei sensitivity, particularly in the second and fourth weeks. This is consistent with research by (Khusniyati et al., 2024); (Zellers et al., 2026) which explains that improvements in nervei conduction duei toi exercisei interventions typically begin to appear between the second and sixth weeks of therapy.

Overall, this study confirms that diabetic foot exercises are simple yet effectivei exercises that improvei foot sensitivity and help prevent complications of diabetic neuropathy, although responses may vary between limbs.

**Tabel 6.** Effectiveness of diabetic foot exercises on pain in type 2 diabetes mellitus sufferers in the Karang Pule Community Health Center work area, Mataram City

| Pain | Tes | Negative Ratings | Positive Ratings | P-Value |
|---|---|---|---|---|
| Week 1-Week 4 | 8 | 7 | 0 | 0.014 |

Based on the results of the Wilcoxon Signed Rank Test on pain levels between the first and fourth weeks, the scores were 8, negative ranks 7, and positive ranks 0, with a p-value of 0.014. These results indicate that 7 respondents experienced a decrease in pain, 8 respondents remained unchanged (no change), and no respondents experienced an increase in pain. A p-value <0.05 indicates a statistically significant difference, thus concluding that the intervention was effective in reducing pain levels in respondents.

The results showed a significant decrease in pain between the first and fourth weeks in patients with type 2 diabetes mellitus after participating in diabetic foot exercises (p = 0.014). Of the 15 respondents, 7 experienced a decrease in pain, 8 respondents remained unchanged, and no respondents experienced an increase in pain. These findings confirm that diabetic foot exercises have a therapeutic effect in reducing pain, particularly the neuropathic pain commonly experienced by people with type 2 diabetes.

This pain reduction can be explained by the physiological mechanisms of foot exercises, which increase blood circulation to the lower extremities, improve oxygen diffusion to tissues, and reduce the stagnation of pain-causing metabolites. Dorsiflexion, plantarflexion, and stretching movements of the foot muscles help activate the muscle pump and improve peripheral nerve perfusion, thereby reducing the frequency of pain impulses caused by neuropathy (Indarti & Palupi, 2018). These research findings align with a study (Pradana & Pranata, 2023) showing that regular foot exercises performed for four weeks can reduce neuropathic pain levels in patients with type 2 diabetes. Another study by (Qurotulnguyun et al., 2020) also reported that diabetic foot exercises can reduce pain by increasing nerve conduction velocity and improving peripheral nerve function. Furthermore, (Ustadiyah et al., 2024) found that stretching and joint mobilization activities in the lower extremities can reduce mild inflammation in nerve tissue and improve patient comfort.

The significant reduction in pain within four weeks of this intervention also suggests that light, structured exercise can provide relatively rapid hemodynamic and neurological effects. This is consistent with statements (Brahmantia et al., 2020) and (Pramesti, 2023) that pain improvement from peripheral nerve stimulation typically begins to be seen between the second and sixth weeks of physical therapy. Overall, the results of this study strengthen the evidence that diabetic foot exercises are an effective, safe, and easy-to-implement non-pharmacological intervention to help reduce neuropathic pain in people with type 2 diabetes mellitus.

The clinical implications of these findings include the need for an individualized therapeutic approach (personalized care) and regular evaluation of the intervention's

effectiveness. Patients who do not experience pain relief may require a combination of additional therapies, both pharmacological and non-pharmacological, or a longer intervention duration to achieve optimal results. However, the absence of increased pain in all respondents indicates that diabetic foot exercises are a safe intervention and remain beneficial as supportive therapy in preventing neuropathy worsening. This is supported by the International Diabetes Federation (2021), which states that structured physical activity plays a crucial role in improving nerve function and quality of life for diabetes patients.

# CONCLUSION

The research findings indicate that diabetic foot exercises are effective in reducing neuropathic pain and increasing foot sensitivity in patients with Type 2 Diabetes Mellitus. After four weeks of intervention, there was a significant reduction in pain ($p = 0.014$) and an increase in peripheral nerve sensitivity. Right foot sensitivity increased significantly in the first week ($p = 0.013$), the second week ($p = 0.001$), and the fourth week ($p = 0.008$), while the left foot showed a significant increase in the first week ($p = 0.013$). Thus, foot exercises can be recommended as a safe, inexpensive, and easily implemented non-pharmacological intervention in primary healthcare to help control diabetic neuropathy complications in patients with type 2 diabetes.

This study has limitations such as its quasi-experimental design without randomization, its small sample size and limited study site, and the use of subjective measurements, which limit the generalizability and accuracy of the results. For further development, it is recommended that research use a randomized controlled trial (RCT) design with a larger sample size and multi-center involvement. It also recommends testing the effectiveness of combination therapy using more objective measurement tools and a longer follow-up period to obtain stronger and more comprehensive evidence.

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