



OVERVIEW OF FOOT SENSORY SENSITIVITY IN PATIENTS WITH TYPE 2 DIABETES MELLITUS AFTER PERFORMING DIABETIC FOOT EXERCISES USING A BALL AS A MEDIUM

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ABSTRACT

Type 2 diabetes mellitus is a chronic metabolic disorder that can lead to complications such as peripheral neuropathy, characterized by decreased sensory sensitivity in the feet. One recommended non-pharmacological intervention is diabetic foot exercise using a ball as a medium. This study aims to describe changes in foot sensory sensitivity in patients with type 2 diabetes following diabetic foot exercise therapy using a ball. A descriptive case study approach was employed involving two elderly participants with diabetic neuropathy. The intervention consisted of six sessions over two weeks, with each session lasting 15–20 minutes. Evaluation was conducted using the 10g monofilament test and in-depth interviews. The results indicated an increase in the number of sensation points detected after the intervention. Subjectively, both patients reported reduced tingling and lighter discomfort in the feet. These findings suggest that diabetic foot exercise using a ball can stimulate peripheral nerves and improve blood circulation. This foot exercise can be performed regularly by individuals with type 2 diabetes mellitus to maintain good sensory sensitivity in the feet and ensure optimal nerve function.

KEYWORDS

Type 2 Diabetes Mellitus; Foot Sensory Sensitivity; Diabetic Foot Exercise; Ball Medium; Peripheral Neuropathy

INTRODUCTION

Diabetes mellitus, commonly referred to as diabetes, is a group of metabolic disorders characterized by prolonged elevated blood glucose levels (Saha et al, 2020). Currently, diabetes mellitus represents a significant global health threat. Various studies have shown that the incidence and prevalence of type 2 diabetes mellitus are expected to increase worldwide. One of the common microvascular complications of diabetes mellitus is diabetic neuropathy, which is indicated by a decrease in foot sensory sensitivity (Lestari et al., 2021). Moreover, the risk of developing diabetic neuropathy is influenced by several factors, including poorly controlled blood glucose levels, the duration of the disease, lifestyle factors, hypertension, and other comorbid conditions. If left untreated, diabetic neuropathy can lead to a complete loss of foot sensory sensitivity (Prasetyani & Martiningsih, 2019; Utomo et al., 2024).

Diabetic neuropathy, whether mild or severe, is a common complication experienced by individuals with diabetes and may lead to sensory loss and damage in the lower extremities. It is a manifestation of nerve dysfunction in individuals with diabetes mellitus. If blood glucose levels remain elevated for an extended period and are not properly managed, this condition can damage and weaken the walls of capillary blood vessels that deliver nutrients to the nerves. Consequently, this damage may result in nerve impairment, known as diabetic neuropathy (Tomic et al., 2022). The symptoms of diabetic neuropathy vary widely, including tingling sensations, cramps, numbness, pain, and even muscle weakness (Prasetyani & Martiningsih, 2019).

The increasing prevalence of diabetes mellitus cases in Indonesia has led to a rise in diabetes-related complications, such as decreased foot sensory sensitivity caused by neuropathy. According to the International Diabetes Federation (IDF) Diabetes Atlas 2021, the prevalence of diabetic neuropathy in Indonesia is considerably high, affecting approximately 17.6% of individuals with diabetes. Globally,

diabetic peripheral neuropathy affects about 30% of diabetes patients. Neuropathy typically begins with a loss of sensation in the feet and gradually spreads symmetrically upward. These early symptoms are often overlooked until the condition worsens and becomes more difficult to manage (Paju et al., 2022; Rahmani et al., 2025).

According to the American Diabetes Association (2021), non-pharmacological therapy in the form of diabetic foot exercises is recommended as a physical activity for individuals with diabetes mellitus. This intervention aims to prevent the occurrence of foot complications and improve blood circulation. It is particularly suitable for patients with diabetic neuropathy (Simamora et al., 2020). Diabetic foot exercises help increase blood flow, resulting in the opening of more capillary networks, which in turn activates insulin receptors and contributes to lowering blood glucose levels in people with diabetes mellitus (Muzaiyanah & Isnawati, 2024; Yulis Hati et al., 2020). This activity is easy to perform by anyone, and its objectives include improving blood circulation, addressing joint movement limitations commonly experienced by diabetic patients, and preventing the development of diabetic foot ulcers. One of the tools used is a ball, where the patient places a tennis ball on the floor and is instructed to press and roll the ball using their foot (Aryanto et al., 2024; Basri et al., 2021).

Based on the aforementioned phenomenon, the researcher is interested in conducting a study on the sensory sensitivity of the feet in patients with type 2 diabetes mellitus after undergoing diabetic foot exercise therapy using a ball. This interest stems from the practicality of the intervention, as it does not require special training and can be performed independently by the patient. Although similar studies have been conducted, previous research has primarily focused on changes in blood glucose levels following diabetic foot exercises using a ball. In contrast, this study focuses specifically on the sensory sensitivity of the feet in patients with type 2 diabetes mellitus after undergoing six sessions of diabetic foot exercises using a ball, performed routinely—three times per week, with each session lasting 15–20 minutes at the respective homes of the subjects, located in RW 07, Mangliawan Village, Malang Regency.

MATERIALS AND METHODS

The research method employed in this study is a case study with a descriptive approach. Descriptive narrative analysis was used to interpret interview and observation data. The study involved two participants who exhibited symptoms of diabetic neuropathy complications, namely Subject 1 (63 years old) and Subject 2 (72 years old), both residing in RW 07, Mangliawan Village, Malang Regency. The selection of subjects was based on specific inclusion and exclusion criteria. The inclusion criteria were: individuals diagnosed with type 2 diabetes mellitus, showing signs of diabetic neuropathy, and having no injuries or open wounds, with both feet in clean condition. The exclusion criteria included: uncooperative patients, those with lower extremity injuries, or the presence of diabetic foot ulcers.

RESULTS

Characteristics of Research Subjects

Table 1. Subject Demographics

Variable	Subject 1	Subject 2
Age	63 years	65 years
Gender	Male	Female
Employment status	Retired Civil Servant	Housewife
Diagnosis	DM type 2	DM type 2
Duration of illness	4 years	7 years
Medications	None	Metformin 500gr

Interview Results

Table 2. Subject Responses Before Intervention

Questions	Subject 1	Subject 2
How long have you been diagnosed with diabetes mellitus?	"I have been living with diabetes mellitus for approximately four years, since 2021"	"I've probably had diabetes for more than seven years"
How often do you experience tingling or numbness in your feet?	"Sometimes, Miss, when I'm doing activities, I suddenly feel tingling and cramps in my feet"	"The tingling happens almost every night, Miss, sometimes it even turns into numbness. My feet also feel heavy when I do activities, especially the left one"
How do you manage your diabetes on a daily basis?	"Since I found out I had diabetes, I've been doing a morning walk every day for about 30 to 45 minutes, and my wife also manages my diet"	"I take 500 mg of metformin every day, Miss—sometimes once, sometimes twice a day. I also have regular monthly check-ups, either at the elderly health post (<i>posyandu lansia</i>) or at Dr. Luhung's clinic"
Have you ever tried diabetic foot exercise therapy before?	"No, I haven't, Miss"	"Yes, I have, Miss. I once did diabetic foot exercises together with other mothers at the elderly health post (<i>posyandu lansia</i>) led by the <i>posyandu</i> health cadres, but it was a long time ago"
Have you ever tried using a ball as a medium for diabetic foot exercise therapy?	"No, I haven't, Miss"	"No, I haven't"

Table 3. Subject Responses After Intervention

Questions	Subject 1	Subject 2
Do you feel any changes in the sensory sensitivity of your feet after performing diabetic foot exercise therapy using a ball?	"Yess, Miss"	"There were changes"
Could you describe what changes you have felt?	"After one week of doing the diabetic foot exercise with the ball, I felt that the sudden cramps started to decrease, and the tingling didn't happen as often as it used to"	"Yes, Miss, after doing the diabetic foot exercise with you, my feet felt more comfortable and lighter when I did activities. At night, the tingling didn't reach the point of numbness like before, and it doesn't happen every day anymore"
Have you experienced a decrease in the frequency of tingling or numbness after performing diabetic foot exercise therapy using a ball?	"Yes, Miss, after one week of doing the diabetic foot exercise using a ball, the tingling has reduced quite a bit"	"At night, the tingling isn't as frequent as before, and it doesn't get to the point where my feet go numb anymore"
Have you experienced any side effects from the diabetic foot exercise therapy using a ball?	"The first time I did the diabetic foot exercise using a ball, my feet felt cramped. But by the second session, the cramping was gone"	"During the first week, my feet felt cramped and still stiff. But by the second week, they started to feel better"

Research Results

Table 4. Right Foot Monofilament Test Results of Subject 1 and Subject 2 Before the Intervention

Subject	Monofilament Test Results – Session No.					
	1	2	3	4	5	6
Subject 1	5	2	3	5	6	7
Subject 2	5	4	5	7	5	8

Table 5. Right Foot Monofilament Test Results of Subject 1 and Subject 2 After the Intervention

Subject	Monofilament Test Results – Session No.					
	1	2	3	4	5	6
Subject 1	5	6	6	7	8	9
Subject 2	2	3	6	6	7	7

DISCUSSION

Level of Foot Sensory Sensitivity Before Performing Diabetic Foot Exercise Using a Ball in Mangliawan Village

According to the observational data obtained through the monofilament test and interviews with Subject 1 before and during the diabetic foot exercise using a ball, the foot sensory sensitivity showed gradual improvement over six sessions. In the first session, Subject 1 was able to perceive 5 contact points on the right foot and 3 points on the left foot. In the second session, the right foot sensed 2 points while the left sensed 5 points. In the third session, the right foot sensed 3 points and the left foot remained at 5 points. In the fourth session, sensory sensitivity increased to 5 points on the right foot and 7 points on the left. By the fifth session, the right foot sensed 6 points and the left remained at 7. Finally, in the sixth session, both right and left feet sensed 7 points, indicating a notable improvement in foot sensory function. It is important to note that the first session was conducted immediately after Subject 1 had completed his morning walk, whereas sessions two through six were conducted without prior physical activity. During the interview, when asked about the frequency of tingling or numbness, Subject 1 stated: *"Sometimes, Miss, when I'm doing activities, I suddenly feel tingling and cramps in my feet"*.

Meanwhile, based on the monofilament test and interviews conducted with Subject 2 prior to and during the intervention, the results showed progressive changes in foot sensory sensitivity. In the first session, Subject 2 perceived 5 contact points on the right foot, but in the second session, she sensed only 1 point. In the third session, the right foot sensed 4 points and the left foot sensed 2 points. In the fourth session, the right foot detected 5 points and the left 4 points. By the fifth session, the right foot improved to 7 points, while the left remained at 4. In the sixth session, the right foot sensed 5 points and the left also 4 points. Finally, in the sixth session, the right foot perceived 8 points and the left foot 6 points, indicating a notable improvement. During the interview, when asked about the frequency of tingling and numbness, Subject 2 stated: *"The tingling happens almost every night, Miss, sometimes it even turns into numbness. My feet also feel heavy during activity, especially the left one."*

The decline in foot sensory sensitivity due to diabetic neuropathy is one of the microvascular complications of diabetes mellitus. When blood glucose levels remain elevated for prolonged periods without proper control, the capillary walls that supply nutrients to the nerves can become damaged and weakened, ultimately leading to nerve impairment (Lestari et al., 2021). Common signs and symptoms of diabetic neuropathy include tingling sensations, burning pain, numbness, muscle weakness, muscle atrophy in the hands or feet, as well as digestive and urinary disturbances (Setiawan et al., 2022).

If diabetic neuropathy is not promptly managed, it can lead to serious complications such as foot ulcers, neuropathic edema caused by increased blood flow to the feet that reduces sympathetic innervation and Charcot atrophy, which is characterized by joint and bone deformities and inflammation in the midfoot. Therefore, the management of diabetic neuropathy is a critical priority in the care of patients with diabetes (Bilous & Donnelly, 2022).

According to the researcher, prior to undergoing diabetic foot exercise therapy using a ball, both subjects showed signs of sensory disturbances indicative of diabetic neuropathy, with varying degrees of severity ranging from initial sensory decline to evident sensory impairment in the feet. This suggests that peripheral neuropathy complications had already begun to develop, potentially impacting the patients' quality of life, particularly in terms of foot sensory comfort and function. If left unaddressed, these disturbances pose a risk of progressing to more severe complications, such as diabetic foot ulcers.

Level of Foot Sensory Sensitivity After Performing Diabetic Foot Exercise Using a Ball in Mangliawan Village

Based on the observations conducted through the monofilament test and interviews with both subjects, Subject 1 and Subject 2, who participated in six sessions of diabetic foot exercise using a ball over a two-week period, there was a noticeable improvement in foot sensory sensitivity. This improvement was evidenced by an increase in the number of pressure points that responded to the monofilament stimulus.

Following the diabetic foot exercise therapy using a ball, Subject 1 showed progressive improvements in foot sensory sensitivity based on the monofilament test results. In the first session, both the right and left foot detected 5 contact points. In the second session, sensitivity increased to 6 points on both feet, and remained at 6 points in the third session. In the fourth session, the right foot maintained 6 points, while the left increased to 7 points. By the fifth session, both feet sensed 8 points, and in the final session (session six), the right foot remained at 8 points while the left foot further improved to 9 contact points. Subject 1 consistently performed the therapy according to schedule—six sessions over two weeks, with each session spaced two days apart. During the post-intervention interview, Subject 1 reported: *"After one week of doing the diabetic foot exercise with the ball, I felt that the sudden cramps started to decrease, and the tingling didn't happen as often as it used to."*

Meanwhile, after participating in diabetic foot exercise therapy using a ball, Subject 2 showed changes in foot sensory sensitivity as measured by the monofilament test. In the first session, she sensed 6 contact points on the right foot and 2 on the left. In the second session, the right foot detected 7 points and the left 3 points. In the third session, the right foot remained at 7 points, while the left improved to 6 points. The fourth session showed 8 points on the right foot and 6 on the left. In the fifth session, both feet sensed 7 points. Finally, in the sixth session, the right foot detected 8 points and the left 7 points. It should be noted that Subject 2 did not follow the therapy schedule as planned. The interval between the fourth and fifth sessions was 4 days, and the sixth session was conducted the day after the fifth, which may have influenced the variability in sensory response points during the monofilament test. During the interview regarding changes experienced after six intervention sessions, Subject 2 stated: *"After doing the diabetic foot exercises with you, Miss, my feet felt lighter during activities, and at night, the tingling sensation no longer progressed to numbness as it did before, nor did it occur daily like before."*

Based on the monofilament test results obtained from Subject 1 and Subject 2, there was an increase in the number of points able to perceive the monofilament stimulus. Initially, the test results indicated that both subjects experienced decreased foot sensory sensitivity, progressing towards sensory impairment in both feet. However, after the intervention involving diabetic foot exercise therapy using a ball, the examination results improved, showing sensory sensitivity levels ranging from mild decrease to normal, without reaching a stage of sensory impairment in either foot.

In managing diabetic complications such as decreased foot sensory sensitivity, pharmacological treatment is not the only option for addressing diabetic neuropathy. Diabetic foot exercises represent a non-pharmacological intervention that patients with diabetes can perform to reduce the severity of neuropathy. This activity is easy to perform by anyone and aims to improve blood circulation, overcome joint mobility limitations, and prevent the occurrence of foot ulcers (Basri et al., 2021).

Diabetic foot exercise is a physical activity designed to improve blood circulation, muscle flexibility, and nerve stimulation in the foot area. When combined with a ball medium, this exercise not only involves joint and muscle movements but also provides additional pressure as a stimulus on the foot's surface. Based on the theory of neuroplasticity, nerves have the ability to adapt to new stimuli through repetitive activity; therefore, repeated stimulation, as occurs in diabetic foot exercise using a ball, can help restore or enhance sensory function (Hasneli, 2019).

According to the researcher, diabetic foot exercise therapy using a ball is a highly potential non-pharmacological method to improve the quality of life of patients with diabetes mellitus. On the other

hand, the researcher also believes that the success of this intervention is influenced by motivation, the patient's condition prior to therapy, and consistency in performing the therapy. Additionally, factors such as age and duration of diabetes also affect the speed and degree of sensory improvement. This aligns with the study conducted by (Oktaviah, D & Agrina, 2019), which found that foot exercises using a plastic ball performed three times a week were effective in enhancing foot sensitivity in patients with type 2 diabetes mellitus.

CONCLUSIONS

Before the intervention, based on the 10g monofilament test results, Subject 1 experienced decreased foot sensory sensitivity, with positive responses only at some points. Subject 2 showed more severe sensory decline, particularly in the left foot, with very limited stimulation responses indicating progression toward sensory impairment. After regularly undergoing diabetic foot exercise therapy using a ball according to the schedule, Subject 1 demonstrated an increased number of points responding to the monofilament stimulus, indicating improvement in foot sensory sensitivity from previously reduced levels to a condition approaching normal. Subject 2 also experienced sensory improvement, albeit more gradually, due to irregularities in the timing of her interventions. Her improvement was marked by a shift from the sensory impairment phase to a state of decreased sensory loss, approaching normal at several points.

Acknowledgement

Thank you to all those who have contributed to the writing of the literature study.

Funding Source

Thank you to all those who have contributed to the writing of the literature study.

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