



## The effect of foot exercise on increasing sensitivity and blood sugar in type 2 diabetes

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### ARTICLE INFO

#### Article history:

Received Jan 11, 2025

Revised Jan 15, 2025

Accepted Jan 29, 2025

#### Keywords:

Blood Sugar Levels;  
Diabetic Foot Exercises;  
Diabetes Mellitus;  
Foot Sensitivity.

### ABSTRACT

Diabetes Mellitus is a chronic metabolic disorder caused by many factors such as high blood sugar levels resulting from impaired insulin function. Diabetic foot exercises is exercises that can doing with moving the muscles and joints of the feet, improving blood circulation, strengthening small muscles, preventing foot deformities. The monofilament test is a tool to check for nerve damage (peripheral neuropathy), caused by conditions such as diabetes mellitus. Temporary blood glucose is a check of glucose levels in non-fasting blood that can be done at any time. Objective: To determine the effect of diabetic foot exercises toward foot sensitivity and blood sugar levels on diabetes mellitus type 2 patients at Dasan Lekong Public Health Center, East Lombok. Method: The design of this research is quasi-experimental research with a pretest-posttest with control group design. The population in this study was 45 people. While the sample in this study was 18 people. Results: Using the Wilcoxon test, there was an effect of diabetic foot exercises toward foot sensitivity on diabetes mellitus type 2 patients with a p value ( $0.000 < \alpha (0.05)$ ). Likewise, there is an effect of diabetic foot exercises toward blood sugar levels with p ( $0.000$ ). Conclusion: There is an effect of diabetic foot exercises on increasing foot sensitivity and blood sugar levels on diabetes mellitus type 2 patients.

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## 1. INTRODUCTION

Diabetes Mellitus (DM) is a metabolic disease characterized by increased blood glucose concentration (hyperglycemia) due to abnormalities of insulin secretion, abnormal insulin function, or a combination of both. According to data from the International Diabetes Federation (IDF), the global prevalence of Diabetes Mellitus in 2021 reached 10.5% or equivalent to 537 million adults aged 20-79 years, which means 1 in 10 people in the world live with diabetes. The number of diabetes sufferers is projected to increase to 11.3% (643 million people) in 2030 and continue to increase to 12.2% (783 million people) in 2045 (Webber, 2021). The prevalence of Diabetes Mellitus in Indonesia based on Riskesdas from 2013 to 2018 experienced a significant increase, namely from 6.9% to 8.5%. The number of Diabetes Mellitus sufferers in West Nusa Tenggara is 1.6% (19,247 people) of the total number of Diabetes Mellitus sufferers in Indonesia (Wiryakriyana dan widhiyani, 2020).

East Lombok is one of the regencies in West Nusa Tenggara Province. The number of people with Diabetes Mellitus, based on the Puskesmas performance data report in the 2022 period, was 169 people

and experienced a very significant increase to 441 people in 2023. Meanwhile, cases of Diabetes Mellitus at the Dasan Lekong Puskesmas, East Lombok Regency continued to increase with the number of people with diabetes mellitus in 2021 being 90 people. Meanwhile, the number of patients visiting the Dasan Lekong Puskesmas in the last three months from August to October 2022 was 45 people (Puskesmas data report, 2023).

Hyperglycemia in patients with Diabetes Mellitus that is not treated will have an impact on complications of Diabetes Mellitus, one of which is Peripheral Arterial Disease (PAD), namely the formation of atherosclerosis due to thickening of the basement membrane of large and small blood vessels in the peripheral arterial blood flow in the lower extremities. The risk factors for PAD in patients with type 2 Diabetes Mellitus increase with age, gender, duration of Diabetes Mellitus, history of hypertension, low physical activity and history of smoking and hypercholesterolemia (Wiryakriyana dan widhiyani, 2020).

Dangerous complications of Diabetes Mellitus can trigger foot wounds that have the potential to cause infection, foot deformity, and even lead to limb amputation. The main factors that trigger diabetic ulcers include angiopathy, neuropathy, and infection. Peripheral neuropathy causes a decrease or loss of pain sensation in the feet, so that foot injuries can occur without being realized, which ultimately has the potential to trigger ulcer formation. Loss of sensation or decreased sensitivity of the feet is one of the main factors that is at risk of causing ulcers, but there are also several other factors such as uncontrolled hyperglycemia, age over 40 years, patients who have a history of ulcers or amputations, decreased peripheral pulses, and a history of smoking (Saputra et al., 2023).

Sensitivity is one of the symptoms of complications in Diabetes patients which is characterized by nerve damage in the distal area, especially in the lower extremities. This damage occurs symmetrically and has the potential to spread to the proximal area (Briliani, 2019). Contraction of muscle cells increases sensitivity to insulin, allowing high blood glucose in the blood vessels to be utilized by the muscles as an energy source. This decrease in blood glucose levels also reduces the accumulation of glucose, sorbitol, and fructose in nerve cells (Nur, Hasrul, 2021). Physical activity involves various joint movements or stretching in all directions and can increase blood flow to the lower extremities so that it can prevent the onset of peripheral arterial disease in patients with Diabetes Mellitus. Physical activity can also increase the sensitivity of insulin receptors in active muscles so that it can increase glucose use in cells (Nur, Hasrul, 2021). Physical exercise is one of the four main pillars in the management of Diabetes Mellitus. One form of physical exercise recommended for Diabetes Mellitus patients is Diabetic Foot Exercises.

Foot exercises for Diabetes Mellitus sufferers are activities or exercises undertaken by Diabetes Mellitus sufferers to help smooth blood circulation in the legs which can reduce the degree of nerve disorders. This foot exercise provides various benefits, both for patients who have experienced nerve disorders and those who have not. The benefits include strengthening small muscles, calf muscles, and thigh muscles, as well as helping to reduce limitations of joint movement that are commonly experienced by Diabetes Mellitus sufferers. The effects of foot exercises can prevent wounds and help smooth blood circulation in the leg (Brahmantia et al., 2020). Previous research conducted by (Brahmantia et al., 2020) stated that there was a significant increase in skills after six months of training. Thus, foot exercises that are carried out routinely and in a balanced manner can have a positive impact on people with Diabetes Mellitus and there is an average difference in foot sensitivity values and physical examination of the feet between the control group and the intervention group.

Based on the results of a preliminary study conducted by researchers on November 14, 2023 on 6 Diabetes Mellitus patients who visited the Dasan Lekong Health Center, East Lombok Regency, through the interview method, data was obtained that the patients said they had had DM for more than 2 years and rarely checked their blood sugar either at the Health Center or independently. Of the 6 patients interviewed, 5 said they often felt tingling in their feet, 5 people felt numbness in the soles of their feet and 4 people experienced pain in their feet. Patients who visited the Health Center rarely did physical activities such as sports and other physical exercises and had never been involved in Diabetic Foot

Exercise therapy. Based on information from the Health Center holding the non-communicable disease (PTM) program, it said that patients who visit are still given medication and diet education and regular exercise as one of the physical exercises and included in the program for non-communicable diseases, but not all Diabetes Mellitus sufferers come to participate in the activity while more specifically towards diabetic foot exercise, DM exercise, Range Of Motion (ROM) and foot sensitivity examination using monofilament test has never been done. Therefore, it is necessary to conduct research on the effect of Diabetic Foot Exercise on Foot Sensitivity and decrease in blood sugar levels in Type 2 Diabetes Patients at the Dasan Lekong Health Center, East Lombok Regency.

## 2. Method

The design of this study is a quasi-experimental study with a pretest-posttest with control group design (Fauzi et al., 2022). This design was chosen to evaluate the effect of diabetic foot exercises on foot sensitivity and blood sugar levels in patients with type 2 Diabetes Mellitus (DM). The population in this study were all Diabetes Mellitus patients from August to October 2023 in the Dasan Lekong Health Center work area totaling 45 people and the sample in this study was 18 people. The data collection method was carried out using several methods, namely by using a questionnaire that aims to identify age, gender, duration of Diabetes Mellitus. Monofilament test 10g was used to measure foot sensitivity and Blood Sugar Check (GDS) was used to measure blood sugar levels. Furthermore, the collected data will be analyzed univariately and bivariately. Univariate analysis or descriptive analysis was carried out to explain the characteristics of age, gender, duration of diabetes, foot sensitivity, and blood sugar levels. Meanwhile, bivariate analysis to assess whether diabetic foot exercise has an impact on foot sensitivity and blood sugar levels in patients with type 2 diabetes mellitus, the test used in this study is the Wilcoxon Signed Rank Test with SPSS software, where  $[\alpha] = 0.05$ . The analysis was carried out computerized to see the impact of diabetic foot exercise on foot sensitivity and blood sugar levels in patients with type 2 diabetes mellitus, and if the data scale is normal, a parametric test in the form of a Paired T-Test is used.

## 3. Results and Discussion

**Table 1.** Characteristics of respondents based on age

	N	Minimum	Maximum	Mean	SD
Age	18	45	60	53.44	5.843
Listwise	18				

The results of the study in Table 1 show that from a total of 18 respondents, the highest age was 60 years and the lowest age was 45 years. The average age of respondents was recorded at 53.44 years with a standard deviation of 5.843. Based on table 1, it was found that the frequency of age of diabetes mellitus sufferers was mostly 60 years. This finding is in line with research conducted by (Suryati et al., 2019) which says that age causes changes in the ability of pancreatic beta cells to produce insulin. According to (Setia et al., 2021) risk factors for type 2 Diabetes Mellitus sufferers occur at the age of over 30 years, this occurs due to a decrease in the anatomical, physiological, and biochemical aspects of the body, generally diabetes mellitus sufferers occur at the age of > 45 years. At this age, a process called aging begins to occur which causes the ability of pancreatic beta cells to produce insulin to decrease, resulting in glucose intolerance. This is related to a decrease in the sensitivity of the sufferer's feet.

**Table 2.** Respondent characteristics based on gender

Gender	F	%
Female	12	66,7
Male	6	33,3
Total	18	100

The research results in Table 2 show that of the total 18 respondents, the majority were female, namely 12 people (66.7%), while there were 6 male respondents (33.3%). Based on table 2, it was found that the gender of diabetes mellitus sufferers was mostly female, numbering 12 people (66.7%), while the gender

was male, numbering 6 people (33.3%). This finding is in accordance with research conducted by (Suryati et al., 2019) said that women experience Diabetes Mellitus more often than men. The results of this study are supported by the opinion of (Suryati et al., 2019) which says that women are more at risk of experiencing decreased foot sensitivity, this occurs due to decreased estrogen hormone levels as a result of menopause. Estrogen basically functions to maintain stable blood sugar levels and increase triglyceride storage, as well as the hormone progesterone which plays a role in stabilizing blood sugar levels and supporting the use of triglycerides as an energy source.

**Table 3.** Respondent characteristics based on length of time suffering from diabetes mellitus

	N	Minimum	Maximum	Mean	SD
Long time DM	18	1	6	3.72	1.447
Listwise	18				

Based on the data in Table 3 regarding the frequency distribution of respondents based on the duration of suffering from Diabetes Mellitus, it is known that the length of time since respondents were diagnosed with Diabetes Mellitus ranged from 1 to 6 years. The average duration of diagnosis in respondents was 3.72 years or rounded up to 4 years, with a standard deviation of 1.447. Based on table 3, it was found that the duration of suffering from diabetes mellitus was mostly those who had type 2 diabetes mellitus, namely the minimum value of respondents who had been diagnosed with diabetes mellitus was 1 year and the maximum value of respondents who had been diagnosed with diabetes mellitus was 6 years, with an average duration of respondents diagnosed with diabetes mellitus being 3.72 years or 4 years, and a standard deviation of 1.447. The results of the study conducted by (Muliyah, Dyah Aminatun, Sukma Septian Nasution, Tommy Hastomo, Setiana Sri Wahyuni Sitepu, 2023) explained that epidemiologically diabetes mellitus is often not identified, and it is stated that the onset of diabetes occurs 5 years before the diagnosis is made, which causes early morbidity and mortality in undetected cases. A person who has just experienced diabetes mellitus is likely to experience complications because the symptoms of experiencing complications develop rapidly so that they are only felt or realized after complications occur, so screening is needed for diabetes mellitus patients for preventive measures against complications.

**Table 4.** Frequency distribution and percentage of respondents based on pretest and posttest values of Sewatu Blood Sugar (GDS) levels for 2 days before and after the intervention

GDS	Min		Mean	Sd
	Pre Test	Post Test		
Day 1	201	330	257.67	43.745
Day 2	190	345	254.50	46.218
Pre Test	202	358	268.44	45.600
Post Test	170	275	198.83	31.075

Based on the results of the study in Table 4, on the first day of the pre-test, the minimum GDS value was recorded at 201 mg/dL, while the maximum value reached 330 mg/dL, with an average of 257.67 mg/dL and a standard deviation of 43.745. On the first day of the post-test, the minimum GDS value was 190 mg/dL, the maximum value was 345 mg/dL, the average was 254.50 mg/dL, and the standard deviation was 46.218. Furthermore, on the second day of the pre-test, the minimum GDS value was recorded at 202 mg/dL and the maximum value was 358 mg/dL, with an average of 268.44 mg/dL and a standard deviation of 45.600. Meanwhile, the results of the second day's post-test showed a minimum GDS value of 170 mg/dL and a maximum value of 275 mg/dL, with an average of 198.83 mg/dL and a standard deviation of 31.075.

### 3.1. Analysis of average blood sugar levels before the Diabetic Foot Movement

The amount of blood sugar in respondents before the intervention is described in table 4 shows that the average pre-test value on the first day of the intervention is 257.67 while on the second day it is at 268.44. These results indicate that blood glucose levels before the intervention did not decrease, but increased. This can be assumed because there was no intervention given.

Increased blood glucose levels are known as hyperglycemia, which leads to common clinical symptoms associated with Diabetes Mellitus. Clinical manifestations of high blood sugar levels are increased frequency of urination (polyuria), excessive thirst accompanied by increased fluid consumption (polydipsia), and as the disease progresses, weight loss even though appetite remains (Selano et al., 2021) there are several factors that affect blood sugar levels such as insulin resistance, age-related beta cell dysfunction and environmental factors that do not support activity.

In this study, the average age of respondents was 53.44 which is included in the early elderly category. Age is one factor that can affect a person's physiological abilities. This finding is in line with the results of research conducted by (Suryati et al., 2019) which states that age affects the ability of pancreatic beta cells to produce insulin. According to (Setia et al., 2021) risk factors for type 2 Diabetes Mellitus sufferers occur in individuals over 30 years of age, this event occurs due to a decrease in the anatomy, physiology and biochemistry of the body, generally diabetes mellitus sufferers occur at the age of >45 years.

In addition, other factors that can affect high blood sugar levels are lack of physical activity. This will have an impact on the accumulation of fat which continues to obesity. A person who is obese will have difficulty using insulin produced by the body (insulin resistance). It is known that, during physical activity, muscles consume stored glucose, causing glucose reserves to decrease. To compensate for this deficiency, muscles will take glucose from the blood, resulting in decreased blood glucose level (Ardiani et al., 2021).

### 3.2. Analysis of average blood glucose levels after implementing the Diabetic Foot Movement intervention

The amount of blood sugar in respondents after the intervention is described in table 4 shows that the average post-test value on the first day of the intervention decreased from 257.67 to 254.50 while the average post-test blood sugar level of respondents on the second day of the intervention also decreased from 268.44 to 198.83. This can be assumed due to the intervention given.

One of the main components in the management of diabetes mellitus (DM) is physical activity, which plays a role in increasing insulin sensitivity and maintaining body fitness. Physical activity allows glucose to enter cells without the need for insulin. In addition, physical exercise is also effective in reducing weight in obese diabetics and inhibiting the development of impaired glucose tolerance to DM (Making et al., 2023)

From the research results, it is known that the decrease in blood sugar levels showed a slight difference. This is likely because some respondents were over 50 years old and were unable to perform physical activity optimally. To obtain optimal results, physical activity needs to be done at least 3 to 4 times per week with a minimum duration of 30 minutes per session. This activity does not have to be heavy, just taking a leisurely walk in the morning while enjoying the scenery for 30 minutes or more meets the criteria for good physical activity. In order for blood sugar levels to remain controlled within normal limits, this activity needs to be done routinely and consistently (Making et al., 2023)

For people with diabetes mellitus in the obese weight category, weight loss and blood glucose will be maximized if physical exercise is done more than 5 times per week. Physical exercise is done at least 3 times per week with no more than 2 consecutive days without physical exercise, the goal is for blood sugar levels to decrease normally (Taher, 2020).

**Table 5.** Frequency distribution and percentage of respondents based on pretest and posttest values of right and left foot sensitivity for 2 days before and after the intervention.

Sensitivity	Mean	Sd	Foot		Foot Sensitivity		Min	Max
			Min	Max	Mean	Sd		
Day 1								
Pre Test				Right Foot	6	8	7.28	.575
				Left Foot	7	9	8.11	.758
Post Test				Right Foot	7	9	7.72	.669
				Left Foot	8	9	8.56	.511

Day 2					
Pre Test	Right Foot	7	8	7.44	.511
	Left Foot	7	9	8.39	.608
Post Test	Right Foot	8	9	8.50	.514
	Left Foot	8	10	9.44	.616

Based on the results of the study in Table 5, on the first day of the pre-test, the sensitivity of the right foot had a minimum value of 6 and a maximum of 8, with an average of 7.28 and a standard deviation of 0.575. The sensitivity of the left foot showed a minimum value of 7 and a maximum of 9, with an average of 8.11 and a standard deviation of 0.758. Meanwhile, on the first day of the post-test, the sensitivity of the right foot had a minimum value of 7 and a maximum of 9, with an average of 7.72 and a standard deviation of 0.669. Meanwhile, the sensitivity of the left foot had a minimum value of 8 and a maximum of 9, with an average of 8.56 and a standard deviation of 0.511.

On the second day pre-test, the right foot sensitivity had a minimum value of 7 and a maximum of 8, with an average of 7.44 and a standard deviation of 0.511. For the left foot sensitivity, the minimum value was 7 and a maximum of 9, with an average of 8.39 and a standard deviation of 0.608. Furthermore, on the second day post-test, the right foot sensitivity had a minimum value of 8 and a maximum of 9, with an average of 8.50 and a standard deviation of 0.514. While the left foot sensitivity had a minimum value of 8 and a maximum of 10, with an average of 9.44 and a standard deviation of 0.616.

### 3.3. Analysis of average foot sensitivity before Diabetic Foot Exercise intervention

The respondents' foot sensitivity values before the intervention as described in table 5 show that the average pre-test value on the first day of the intervention was 7.28 on the right foot and 8.11 on the left foot. Meanwhile, the respondents' pre-test foot sensitivity values on the second day of the intervention were 7.44 on the right foot and 8.39 on the left foot.

Foot sensitivity is one of the clinical symptoms of high blood sugar levels that can affect the function of peripheral nerves. Long onset is one of the factors that causes decreased foot sensitivity in diabetic patients. In this study, it was found that the average duration of diabetes mellitus was 3.72.

Research results by (Fortuna et al., 2023) explained that diabetes mellitus is often not identified, with the onset of the disease estimated to occur around 5 years before the official diagnosis is made. As a result, undetected cases are at risk of premature morbidity and mortality. Someone who has just experienced diabetes mellitus is likely to experience complications because the symptoms of experiencing complications develop rapidly so that they are only felt or realized after complications occur, so screening is needed for diabetes mellitus patients for preventive measures against complications.

### 3.4. Analysis of average foot sensitivity after the Diabetic Foot Exercise intervention

The value of the respondents' foot sensitivity after the intervention described in table 5 shows that the average post-test value on the first day of the intervention showed an increase in foot sensitivity, namely from 7.28 to 7.72 on the right foot and 8.11 to 8.56 on the left foot. While the post-test foot sensitivity value of respondents on the second day after the intervention showed an increase in foot sensitivity, namely from 7.44 to 8.50 on the right foot and 8.39 to 9.44 on the left foot.

Lack of physical activity can cause insulin resistance in people with type 2 Diabetes Mellitus (Yulianti et al., 2021) By carrying out foot exercises in the form of diabetic foot movements in patients with type 2 Diabetes Mellitus, the blood flow supply to the feet can be increased, which ultimately improves foot sensitivity.

This theory is supported by Sanjaya's theory (2019) which states that diabetes mellitus based on age, especially over 40 years, is an important factor because in this age range glucose tolerance disorders begin to occur which will result in decreased foot sensitivity, because most of the people in

this study were >40 years old, as many as 17 people (94.4%). Physical activity is very much needed by the body to help prevent insulin resistance.

**Table 6.** The results of this study are based on diabetic foot movements on blood sugar levels in patients with type 2 diabetes mellitus.

GDS	Ties	Negative Ranks	PositiveRank	P Value
Day 1	0	18	0	0.00
Day 2	0	18	0	0.00

Based on the results of the study in Table 6 analyzed using the Wilcoxon non-parametric statistical test, information was obtained that on the first day, there was a decrease in Random Blood Sugar (GDS) levels in 18 respondents, which was indicated by a negative rank value of 18. In addition, the P value of 0.000 (<0.05) indicates a significant effect of the diabetic foot exercise intervention on blood sugar levels in patients with type 2 diabetes mellitus.

In the next table column, the results of the pre-test and post-test analysis on the second day also showed a decrease in GDS levels in 18 respondents, which was indicated by a negative rank value of 18. The P value of 0.000 (<0.05) again indicates that the diabetic foot exercise intervention has a significant effect on reducing blood sugar levels in patients with type 2 diabetes mellitus.

**Table 7.** Diabetic foot exercises to increase foot sensitivity in patients with type 2 diabetes mellitus.

Sensitivity feet	Ties	Negative Ranks	PositiveRank	P Value
Day 1				
Right Foot	12	0	6	0.02
Left Foot	13	0	5	0.03
Day 2				
Right Foot	0	0	18	0.00
Left Foot	0	0	18	0.00

In the pre-test and post-test table columns on the first day for the right foot, the ties value was 12, negative ranks 0, and positive ranks 6, indicating that the post-test value was higher than the pre-test value. Meanwhile, in the pre-test and post-test columns on the first day for the left foot, the ties value was recorded at 13, negative ranks 0, and positive ranks 5, also indicating that the post-test value was higher than the pre-test value. The results of the statistical test showed a p-value of 0.02 (<0.05), which means that there is a significant effect of diabetes mellitus foot movement intervention on increasing foot sensitivity in patients with type 2 diabetes mellitus.

In the pre-test and post-test table columns on the second day for the right and left feet, the same results were obtained, namely a negative ranks value of 0, indicating no decrease in value from pre-test to post-test, both in terms of average and total value. Meanwhile, the positive ranks value was recorded at 18, indicating an increase in value from pre-test to post-test in all respondents. The p-value for the right and left feet was both 0.00 (<0.05), indicating an effect of diabetic foot movement intervention on increasing foot sensitivity in patients with type 2 diabetes mellitus.

Based on the results of the study, it can be concluded that the null hypothesis (Ho) is rejected and the alternative hypothesis (Ha) is accepted. Therefore, diabetic foot exercise intervention has been proven to have an effect on increasing foot sensitivity and decreasing blood sugar levels in patients with type 2 diabetes mellitus in Montong Ancak Hamlet, Dasan Lekong Health Center working area, East Lombok Regency.

### 3.5. The Effect of Diabetic Foot Movement on Blood Glucose Levels in Type 2 Diabetes Mellitus Patients

The blood sugar levels of respondents before the intervention as described in table 4 show that the average pre-test value on the first day of the intervention was 257.67 while on the second day it was 268.44. The blood sugar levels of respondents after the intervention showed that the average post-test value on the first day decreased from 254.50 to 198.83. The p value for blood sugar levels obtained the same value, namely 0.00, which states that there is an effect after the intervention of diabetic foot

movement on blood glucose levels in patients with type 2 Diabetes Mellitus. The findings from this application are in line with research conducted (Priyanto et al., 2019) stated that foot exercise has an impact on blood glucose levels and foot sensitivity in diabetes mellitus patients where blood sugar levels after the intervention are significantly lower than before the intervention.

Researchers assume that the mechanism of decreased blood glucose levels after doing leg exercises is caused by metabolic changes influenced by physical activity. During leg exercises, the body needs energy, so that previously inactive muscles become active due to increased glucose needs. This sensitivity can last a long time, even after the exercise is finished. Physical activity will increase blood flow, which causes more insulin receptors to be available and become more active, so that glucose is used more by the working muscles, which in turn leads to decreased blood glucose levels (Arvita et al., 2024).

To obtain optimal results, physical activity needs to be done at least 3 to 4 times per week with a minimum duration of 30 minutes per session. The activity does not have to be heavy, just taking a leisurely walk in the morning while enjoying the scenery for 30 minutes or more is enough to meet the criteria for good physical activity. In order for blood sugar levels to remain controlled within normal limits, this activity needs to be done routinely and consistently (Making et al., 2023).

### **3.6. The Effect of Diabetic Foot Exercise on Foot Sensitivity in Type 2 Diabetes Mellitus Patients**

On the first day, the sensitivity of the right and left feet showed a higher post-test result than the pre-test value with a p-value of 0.02 ( $<0.05$ ), which means that there is an impact of diabetic foot exercise on increasing foot sensitivity in type 2 diabetes mellitus patients. Furthermore, the pre and post tests on the second day on the right and left feet obtained the same amount, namely there was an increase in value from pre to post test in 18 respondents. The p-value on the right and left feet obtained the same value, namely 0.00 ( $<0.05$ ), which indicates an effect after the intervention of diabetic foot exercise on increasing foot sensitivity in type 2 diabetes mellitus patients.

The findings of this study are in line with research conducted by (Suryati et al., 2019), which states that physical activity, especially foot exercises, can increase blood flow in the foot area and help stimulate the nerves in the feet to receive stimulation. Therefore, doing diabetic foot exercises can help to increase foot sensitivity in people with diabetes mellitus. Good management is needed to reduce the occurrence of complications of diabetes mellitus. One way is by doing sports or physical activities that can increase glucose use by active muscles so that it can reduce blood glucose levels. Physical activity involves various joint movements or stretching in all directions, in addition it can also increase blood flow to the lower extremities so that it can prevent peripheral artery disease in people with diabetes mellitus. Physical activity can also increase the sensitivity of insulin receptors in active muscles, thereby increasing glucose use in cells (Suryati et al., 2019).

This research is supported by (Arvita et al., 2024) found that diabetic foot exercises have a positive impact on circulation, improving blood flow, increasing walking ability, reducing necrosis, preventing embolism, pain, and cyanosis in blood vessels. According to the assumption of researchers, physical activity has benefits for increasing the sensitivity value of the feet that occur in respondents, proving that there is an effect of diabetic foot exercises on the level of foot sensitivity in patients with type 2 Diabetes Mellitus. In the study, it was found that the average length of time respondents were diagnosed with diabetes mellitus was 3.72 years. Loss of foot sensitivity generally occurs after 5 years of suffering from type 2 diabetes mellitus. Where the wider the spread of DM, the higher the incidence of complications experienced. So that by carrying out early prevention will help reduce complications that can arise, one of which is by doing diabetic foot exercises (Amelia, 2019).

Based on table 6, the ties value is 0, Negative Rank 18, Positive Rank value 0 with p value 0.000 ( $<0.05$ ) meaning there is a difference before and after the diabetic foot exercise intervention is given. According to the research (Dewi et al., 2020) explains, to increase muscle microvascular blood flow, exercise must be done continuously and repeatedly. This process is related to arterial dilation (vasodilation) and increased capillary permeability, which allows glucose absorption by muscle cells.

Diabetic foot exercises have been shown to be effective in improving blood circulation to the lower extremities in patients with diabetes mellitus. There was a significant increase in blood flow to the lower extremities as well as decreased pain in patients with Type 2 Diabetes Mellitus who underwent diabetic foot exercises. Gravity plays a role in emptying the veins and filling the arteries alternately in the legs, which in turn improves blood circulation through foot exercises (Dewi et al., 2020).

#### 4. Conclusions

This study shows that diabetic foot exercise is effective in lowering blood sugar levels and increasing foot sensitivity in patients with type 2 diabetes mellitus. This intervention can improve blood circulation and increase foot sensitivity. However, this study has limitations, such as a small sample size and short intervention duration. Further studies are recommended to involve larger samples and longer intervention periods to confirm these findings. Overall, diabetic foot exercise can be an effective intervention in the management of type 2 diabetes mellitus.

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