International Journal of Health, Economics, and Social Sciences (IJHESS)
Vol. 8, No. 1, January 2026, pp. 570~580
DOI: 10.56338/ijhess.v8i1.10066
Website: https://jurnal.unismuhpalu.ac.id/index.php/IJHESS

Effect of Active Leg Stretching on Foot Sensitivity in Type 2 Diabetes Mellitus Patients at Tilongkabila Health Center

Rahma Aulia Mansur[1], Ita Sulistiani[2*], Gusti Pandi Liputo[3]
Mahasiswa Program Studi Ilmu Keperawatan UNG
Dosen Program Studi Ilmu Keperawatan UNG

***Corresponding Author: E-mail:** itasulistiani@ung.ac.id

Article Info

Article history:

Received 12 Oct, 2025
Revised 21 Dec, 2025
Accepted 08 Jan, 2026

Keywords:

Active Leg Stretching , Type 2 Diabetes Mellitus, Blood Sugar Control, Foot Sensitivity

ABSTRACT

Type 2 diabetes mellitus is a chronic disease that often causes complications of peripheral neuropathy in the form of decreased sensitivity of the legs. This condition increases the risk of diabetic leg injuries to amputation if prevention is not carried out early. One of the nonpharmacological interventions that can be carried out is Active Leg Stretching. This study aims to determine the effect of Active Leg Stretching on foot sensitivity in type 2 diabetes mellitus patients at the Tilongkabila Health Center. This study uses a pre-experimental design with a one group pretest–posttest approach. The study sample was a type 2 diabetes mellitus patient who experienced decreased sensitivity of the legs and was selected using the Purposive Sampling technique. Active Leg Stretching interventions were administered according to standard operating procedures during the study period. Leg sensitivity was measured using monofilament tests before and after the intervention. Data analysis was carried out using the Wilcoxon Signed Rank Test. The results showed an increase in foot sensitivity after being given an Active Stretching Leg intervention with a statistically significant difference (p-value < 0.05). This increase occurs because leg stretching can improve blood flow, reduce muscle stiffness, and improve nerve function, so the sensitivity of the legs increases. It can be concluded that Active Leg Stretching has a significant effect on increasing foot sensitivity in patients with type 2 diabetes mellitus. This intervention is recommended as a simple, safe, and easily applied nonpharmacological therapy in primary health care.

INTRODUCTION

Diabetes mellitus (DM) is a degenerative disease characterized by increased blood glucose levels due to impaired insulin metabolism, potentially life-threatening, and causing long-term complications. Some long-term complications are generally influenced by a variety of factors, one of which is physical activity. (Akhmad Zaenal , 2025) (Squirrelly et al., 2021) Cases of DM worldwide are generally dominated by type 2 DM. The disease is often caused by a lack of physical activity and an unhealthy diet. Low physical activity can trigger insulin resistance, which ultimately increases blood sugar levels in people with type 2 diabetes (Dewa et al., 2022).

According to the Word Health Organization (WHO, 2024) in 2021 DM was the leading factor resulting in 1.6 million deaths, and 47% of all DM-related deaths occurred before reaching the age of 70. About 530,000 deaths due to kidney disorders are caused by DM, as well as high blood sugar levels contribute to about 11% of deaths caused by cardiovascular problems.

According to the International Diabetes Federation, (IDF, 2024) there are approximately 589 million adults aged 20–79 years worldwide living with diabetes. In the Southeast Asian region, the prevalence of DM sufferers reached 78.3 million people. Of the countries in the region, Indonesia is the only country that is included in the list of the top 10 highest number of DM sufferers in the world, with the number of sufferers reaching 19.5 million people.

Based on data obtained from the Gorontalo Provincial Health Office, Gorontalo residents who suffer from DM in 2023 are in Bone Bolango Regency with a total of 5,469 cases, followed by Gorontalo Regency with 4,547 cases, North Gorontalo Regency with 2,825 cases, Pohuato Regency with 1,671 cases, Gorontalo City with 1,426 cases, and Boalemo Regency with 1,281 cases (Health Office Province Gorontalo, 2023) .

Based on the prevalence data obtained, Bone Bolango Regency is included in the first place for the most DM patients in 2025 with a total of 2,179 people spread across various health centers. The highest DM sufferers in Bone Bolango Regency are at the Tilongkabila Health Center with a total of 280 DM sufferers from various age groups, then the second highest is at the Kabila Health Center with a total of 249 patients, and the third highest is at the Tapaa Health Center with a total of 214 patients (Health Office Districts Bone Bolango, 2025) .

The proportion of occurrence of type 2 DM reaches 95% in the global population. In Indonesia, about 15% of patients have diabetic lesions, with an amputation rate of 30% and a mortality rate of up to 32%. . Complications in the legs due to DM are the main cause of amputation, this condition is generally triggered by peripheral neuropathy, peripheral vascular disease, and infections, which increase the risk of amputation. Peripheral neuropathy causes a loss of sensation in the legs, so patients are often unaware of the presence of injuries or problems in the legs. Leg complications due to DM reflect the serious impact of this disease, so it needs to be viewed not only from a clinical point of view, but also as a public health problem (Florenza) Laowo et al., 2021) (Srivastava , 2024) .

Based on the overall data, it can be concluded that DM is not only a global health burden, but also a serious challenge at the national and local levels. The high incidence rate, low early detection, and high risk of complications demand more holistic and intensive treatment. Therefore, promotive, preventive, and strengthening community-based interventions are needed to reduce the incidence rate and reduce the long-term impact of this disease. (Yulia et al., 2022) .

One of the efforts to prevent complications in the lower extremities due to DM is through the provision of physical activity exercises. Lack of physical activity through regular exercise in individuals with DM can trigger the onset of diabetic neuropathy. Stretching actively can contribute to increased leg sensitivity as well as improve peripheral nervous system flexibility for people with DM (Ervanti et al., 2023) (Dwi Wahyuningsih & Kusumaningrum , 2021) .

Prevention of diabetic ulcers can be done by controlling blood sugar levels through medication and diet arrangement and applying exercise or physical activity regularly. One alternative method is to do active stretching which functions to increase blood flow to the peripheral area and is able to lower blood sugar levels (São Paulo Chrisanto , 2020).

In several previous studies conducted by Pablo N et al. (2024), it was stated that active leg stretching for people with DM can play a role in lowering glycemia both acutely and chronically and preventing complications. Based on research conducted by Vanny Dearmisa Damanik et al (2024), entitled The Effect of (Nascimento Folha et al., 2024) Active Leg Stretching on Reducing Blood Glucose Levels in DM Patients, it is explained that active stretching in DM patients can help prevent foot deformities, strengthen small muscles, and improve blood circulation. In addition, this exercise has the potential to overcome joint movement limitations and can lower blood sugar levels in DM patients. Based on research presented by Herni et al (2022), entitled The Effectiveness of Diabetic Gymnastics Exercises on Lowering Blood Glucose, diabetic gymnastics has an effect on blood glucose levels because it is directly related to increasing the speed of glucose recovery in muscles, namely how much the muscles absorb glucose from the bloodstream. During exercise, muscles use glycogen as an energy source. When glycogen reserves are reduced, muscles will fill the void by absorbing glucose from the bloodstream through glucose receptors found on muscle cell membranes. Then based on research conducted by James J. Yahaya, Irene F. Emmanuel, et al. (2023) entitled Poor glycemic control and related factors in type 2 DM patients, it is explained that type 2 DM patients experience poor blood sugar level control, with the main cause being non-compliance with routine control which leads to long-term complications, one of which is problems with peripheral neuropathy (Vanny Damanik, 2024) (Herni et al., 2022) (Yahaya et al., 2023) .

A number of previous studies have proven the benefits of stretching exercises in patients with type 2 DM, but most have focused on only one aspect. Some studies have focused on the effect of stretching on lowering blood sugar levels, while others have focused on improving foot sensitivity. Both variables are related and both have the potential to experience a significant decrease in DM patients. Decreased sensitivity of the feet generally occurs in 30–50% of diabetic patients after more than 10 years of suffering from the disease, characterized by loss of protective sensation during monofilament examination and

clinical complaints in the form of baal and tingling. Meanwhile, fasting blood sugar levels in uncontrolled type 2 DM patients can increase to >126 mg/dL, with average blood glucose levels reaching >200 mg/dL, so far above the normal threshold. This condition makes poor blood sugar control accelerate peripheral nerve damage, while decreased sensitivity of the legs reduces the patient's ability to perform physical activities that play a role in lowering blood sugar levels. Therefore, this study is different from previous studies because it examines the effect of (Yahaya et al., 2023) (Ustadiyah et al., 2024) simultaneous active leg stretching on foot sensitivity and blood glucose levels, so it is expected to provide a more comprehensive influence on the benefits of active leg stretching intervention in type 2 DM patients.

Based on the results of initial observations at the Tilongkabila Health Center, of the 10 DM patients who routinely participated in the PROLANIS program, only 2 people stated that they had done leg stretching exercises when they felt numbness or tingling and numbness in the legs as part of self-care, the results of initial observations also showed that there were still many patients who complained of tingling and numbness in the lower extremities. These complaints are generally accompanied by unstable blood sugar levels, thus describing poorly controlled blood sugar control. Although they have received education from health workers through the PROLANIS program, most of them admit that they rarely do physical activity to reduce complaints of numbness or tingling when blood glucose levels are high. The implementation of PROLANIS generally focuses more on dietary regulation and medication administration, while specific physical exercise interventions for the legs are rarely routinely performed. The PROLANIS program at the Tilongkabila Health Center has generally carried out diabetes gymnastics activities regularly as an effort to maintain patient fitness. However, this activity is common with simple aerobic movements and has not focused on leg stretching exercises to prevent decreased sensitivity due to peripheral neuropathy. Based on the existing theory that the legs are the most prone areas to complications in DM, such as ulcers and amputations. From this data, most PROLANIS participants still experience decreased foot sensitivity due to ineffective blood sugar control, influenced by low adherence to medication, unhealthy diet, and lack of physical activity. This is supported by the person in charge of the PROLANIS program who stated that there are several patients who experience decreased sensitivity in the legs. Researchers need to conduct research on the provision (Pratama et al., 2024) of active leg stretching because the PROLANIS program does not do this. Therefore, additional interventions in the form of active leg stretching are needed, which are more specific, easy to do, and can complement the PROLANIS program so that the benefits are not only on general fitness, but also on improving foot sensitivity and blood sugar control in type 2 DM patients.

Active Stretching was chosen because it can increase peripheral blood flow, stimulate sensory nerve function, and help lower blood glucose levels. This exercise is simple, does not require special tools, is easy to learn, and can be done independently at home, thus potentially preventing complications from occurring.

Based on this, the researcher is interested in conducting a study entitled "The Effect of Active Leg Stretching on Foot Sensitivity in Type 2 Diabetes Mellitus Patients at the Tilongkabila Health Center".

RESEARCH METHODS

This research has been carried out at the Tilongkabila Health Center in September-October 2025. The type of quantitative research uses a Quasi-Experimental approach. The design used is a one group pretest-posttest design. The sampling technique in this study used Purposive Sampling with a sample of 50 respondents from 280 populations. This research instrument uses the Monofilament Test to measure the sensitivity of the client's foot, and an observation sheet to record the change in the score on the Monofilament Test.

RESEARCH RESULTS

Univariate Analysis

Characteristics of Respondents Based on Demographic Data

Table 1. Characteristics of respondents by age

Yes	Age	(n)	(%)
1	Young Adults (25-44 years old)	7	14,0
2	Middle Age (45-59 years)	23	46,0
3	ıior (60-74 years old)	19	38,0
4	erly (75-90 years old)	1	2,0
Total		**50**	**100**

Source : Primary Data 2025

Based on the table above, the respondents in this study were 45-59 years old (middle age) which amounted to 23 respondents (46%), and a small proportion were aged 75-90 years (elderly people) which amounted to 1 respondent (2%). Overall, the number of respondents in this study was 50 respondents (100%).

Table 2. Characteristics of respondents by gender

Yes	Gender	(n)	(%)
1	ale	5	10,0
2	omen	45	90,0
Total		**82**	**100**

Source : Primary Data 2025

Based on the table above, the respondents in this study are female, which is 45 respondents (90%), and a small number are male, which is 5 respondents (10%). Overall, the number of respondents in this study was 50 respondents (100%).

Table 3. Characteristics of respondents by Last Education

Yes	Jobs	(n)	(%)
1	IRT	42	84,0
2	Teacher	3	6,0
3	Entrepreneurship	4	8,0
4	Not Working	1	2,0
Total		**50**	**100**

Source : Primary Data 2025

Based on the table above, the respondents in this study as the largest have the last level of elementary education, which is 30 respondents (60%), and a small number have the last level of education of Diploma and Bachelor, which is 3 respondents (6%). Overall, the number of respondents in this study was 50 respondents (100%).

Table 4. Characteristics of respondents based on marital status

Yes	Final Education	(n)	(%)
1	)	30	60,0
2	nior High School	7	14,0
3	gh School	7	14,0
4	ploma	3	6,0
5	chelor	3	6,0
Total		**50**	**100**

Source : Primary Data, 2025

Based on the table above, the majority have marital status, namely marriage, totaling 41 respondents (82%), and a small number have widowed marital status (18%). Overall, the number of respondents in this study was 50 respondents (100%).

Table 5. Characteristics of respondents by occupation

Yes	Marital Status	(n)	(%)
1	arried	41	82,0
2	idow / Doubter	9	18,0
Total		**50**	**100**

Source : Primary Data, 2025

Based on the table above, the respondents in this study as the majority worked as IRTs (Housewives), which amounted to 42 respondents (84%), and a small number did not work, namely 1 respondent (2%). Overall, the number of respondents in this study was 50 respondents (100%).

Table 6. Characteristics of respondents based on blood pressure

Yes	Blood Pressure	(n)	(%)
1	Pre Hypertension	18	36,0

2	Hiertensi Stage 1	15	30,0
3	Hiertensi Stage 2	17	34,0
Total		**50**	**100**

Source : Primary Data, 2025

Based on the table above, the respondents in this study as a large number had blood pressure of 120-139 MmHg (Pre Hypertension) which amounted to 18 respondents (36%), and a small number had blood pressure of 140-159 MmHg (Stage 1 Hypertension), which amounted to 15 respondents (30%). Overall, the number of respondents in this study was 50 respondents (100%).

Table 7. Characteristics of respondents based on BMI

Yes	IMT	(n)	(%)
1	BB Less (<18)	1	2,0
2	Normal BB (18.5-24.9) Excess BB (25-29.9) Obesity (>30)	35	70,0
3		10	20,0
4		4	8,0
Total		**50**	**100**

Source : Primary Data, 2025

Based on the table above, the respondents in this study as a large number had Normal BMI (18.5-24.9) which amounted to 35 respondents (70%), and a small number had Less BMI (<18) which amounted to 1 respondent (2%). Overall, the number of respondents in this study was 50 respondents (100%).

Table 8. Characteristics of respondents based on smoking history

Yes	Smoking History	(n)	(%)
1	Yes	4	8,0
2	No	46	92,0
Total		**50**	**100**

Source : Primary Data, 2025

Based on the table above, the respondents in this study as the majority of non-smokers amounted to 46 respondents (92%), and a small proportion smoked which amounted to 4 respondents (8%). Overall, the number of respondents in this study was 50 respondents (100%).

Table 9. Distribution of Respondents Based on Alcohol Consumption

Yes	Alcohol Consumption	(n)	(%)
1	Yes	1	2,0
2	No	49	98,0
Total		**50**	**100**

Source : Primary Data, 2025

Based on the table above, the respondents in this study as the largest did not consume alcohol, which amounted to 49 respondents (98%), and a small proportion consumed alcohol, namely 1 respondent (2%). Overall, the number of respondents in this study was 50 respondents (100%).

Table 10. Distribution of Respondents Based on the length of time they have been suffering from DM

Yes	Long Suffering from DM	(n)	(%)
1	< 5 years	41	82,0
2	> 5 years	9	18,0
Total		**50**	**100**

Source : Primary Data, 2024

Based on the table above, the respondents in this study as a large number have suffered from DM for 5 years, which is 9 respondents (18%). Overall, the number of respondents in this study was 50 respondents (100%).

Table 11. Distribution of Respondents Based on family history

Yes	Family History	(n)	(%)
1	Yes	30	60,0
2	No	20	40,0
Total		**50**	**100**

Source : Primary Data, 2024

Based on the table above, the respondents in this study as a large number have a family history with DM, which is 30 respondents (60%), and a small number do not have a family history with DM, which is 1 respondent (2%). Overall, the number of respondents in this study was 50 respondents (100%).

Table 12. Distribution of Respondents by DM Complications

Yes	DM Complications	(n)	(%)
1	None	10	20,0
2	Hypertension	17	34,0
3	Hypertension and Cholesterol	7	14,0
4	Gout	2	4,0
5	Hypertension, Cholesterol, and Gout	2	4,0
6	Cholesterol	4	8,0
7	Gout and Cholesterol	5	10,0
8	Hypertension and Gout	1	2,0
9	Goiter then Hypertension	1	2,0
10	Hypertension, Stroke, and Myopia	1	2,0
Total		**50**	**100**

Source : Primary Data, 2024

Based on the table above, the respondents in this study as a large number have a history of complications of DM with Hypertension, which is 17 respondents (34%), and a small number have a history of complications of DM with Cholesterol and Gout, Goiter, Stroke and Myopia, which amounts to 1 respondent (2%).

Bivariate Analysis

Table 13. Analysis of Changes in Leg Sensitivity Before and After Giving Active Leg Stretching in Type 2 DM Patients at the Tilongkabila Health Center

Monofilament	Foot Sensitivity				Red	Sig. (2-tailed)
	Positive		Negatives		22,50	,000
	N	%	N	%		
Pre-Test	50	100	0	0	1,0000	**Total 50**
Post Test	4	8	46	92	1,9200	**Z -6,782**

Source : Primary Data, 2025

The results of the statistical test of foot sensitivity of type 2 DM patients before and after being given active leg stretching showed the results of the Wilcoxon Signed Rank Test with a value of Z = -6.782 with Asymp. Sig (2-tailed) = 0.000, which indicates a significant difference between the pretest and posttest scores of leg sensitivity after active leg stretching ($p < 0.05$). A total of 46 respondents experienced an increase in foot sensitivity, none experienced a decrease, and 4 respondents did not experience any change

DISCUSSION

Levels of leg sensitivity in Type 2 DM patients before and after Active Stretching intervention

Based on the results of the study, pre-test or at the time before being given active leg stretching intervention, all respondents (50 people) showed a decrease in foot sensitivity which was characterized by a negative result of a decrease in neuropathy in the monofilament test. This condition caused respondents to be unable to feel stimulation at the examination points and most also reported complaints in the form of baal, tingling, and numbness in the lower extremities. So that the results of the examination were obtained that the respondents experienced a decrease in foot sensitivity.

Decreased sensitivity of the legs in DM patients occurs due to chronic hyperglycemia that triggers various wrinkles in the peripheral nerves. The journal Frontiers (2024) explains that high blood sugar levels continuously increase the production of Reactive Oxygen Species (ROS), thereby causing oxidative stress and damaging axons, Schwann cells, and myelin which play a role in transmitting sensory stimuli. In addition, hyperglycemia causes damage to the small blood vessels that supply nerves, so that blood flow and oxygen to the nerve tissue decreases and causes nerve hypoxia. (Zhu et al., 2024)

Based on the results of the study, during the post-test there was an increase in foot sensitivity in the respondents. If in the initial measurement the majority of respondents experienced foot sensitivity disorders, then in the post-test measurement as many as 46 respondents showed positive or increased foot sensitivity.

The results were influenced by the respondents' compliance in carrying out the intervention for 5 days, which was carried out in the morning with a duration of about ±10 minutes. According to research conducted by the Army, Goddess Purnamawati , (2022) active leg stretching is proven to reduce muscle tension and increase blood flow. To maximize muscle flexibility, stretching should be done at least once a day or, if possible, several times a day.

Other studies also prove that active leg stretching is able to increase foot sensitivity in DM sufferers. In the journal entitled "The Application of Range of Motion (ROM) Active Feet to Increase Foot Sensitivity in Patients with Diabetes Mellitus" explained that active ROM exercises have a positive effect on increasing foot sensitivity in DM patients. Decreased sensitivity of the feet in diabetics is generally caused by chronic hyperglycemia that triggers peripheral nerve damage, especially in the lower extremities. This condition results in a decrease in the sensory response of the legs so that the patient is at risk of unknowingly injured (Rahmawati & Gati, 2025) .

The administration of active leg stretching intervention is carried out in the morning with a duration of ±10 minutes, and is carried out regularly for 5 consecutive days. In the implementation of active leg stretching, there is a change in the level of foot sensitivity, this is supported by research conducted by Widiyono, et al. (2022) where the administration of diabetic foot gymnastics plays an important role in helping to smooth and improve blood circulation in the legs. The movements performed in this exercise cause contractions of the leg muscles, which in turn increases the sensitivity of cells to blood glucose. In addition, smoother blood circulation also contributes to increased tissue oxygenation, prevention of peripheral neuropathy, as well as maintaining lower extremity health in DM sufferers. (Widiyono et al., 2022)

Then during the post-test after being given an active leg stretching intervention, the number of respondents who experienced changes in foot sensitivity increased by 46 respondents and those who did not experience an increase in foot sensitivity as many as 4 respondents. Although most of the respondents showed increased leg sensitivity after being given an active leg stretching intervention, there were still 4 respondents who did not experience any changes. This condition can be explained by several clinical and physiological factors. One of the factors that is suspected to play a role is the possibility of developing diabetic neuropathy in the advanced stage, so that the erosion of the peripheral nerve has lasted for a long time and the regeneration process is slower. Another factor that should also be considered is the level of compliance and accuracy of respondents in performing (Maugeri et al., 2021) active stretching movements, which can affect the effectiveness of interventions. Differences in intensity, frequency, and technique of exercise implementation have the potential to cause variations in the results obtained.

These findings suggest that although active leg stretching interventions are effective in most respondents, responses to interventions may vary between individuals. This confirms the importance of a comprehensive therapeutic approach in the management of diabetic neuropathy.

The majority of respondents in this study were in the elderly age group, this data is presented as an overview of the profile of the respondents in the study. Theoretically, the aging process is related to physiological changes in nerve tissues and blood vessels, but in this study the age factor was not statistically analyzed as a variable that affects the sensitivity of the legs, but was only used to describe the characteristics of the study subjects. This is in line with the findings by those who explain that the aging process causes a decrease in tissue elasticity, reduced nerve function, and a slowdown in nerve regeneration. This condition makes the nerves in elderly individuals more susceptible to damage due to hyperglycemia exposure, so it can scientifically justify the high risk of neuropathy in the age group in the

study. Yang et al., (2025)

In the study conducted by the state, typical conditions in the elderly that can worsen the sensitivity of the legs include a decrease in the elasticity of blood vessels, a decrease in muscle mass, and microcirculation disorders that cause the nerve recovery process to run slower. The aging process also contributes to the thickening and stiffening of the walls of the blood vessels, thereby lowering the perfusion of blood to the peripheral nerves. Squirt & Pratama Sari, (2021)

In addition to age, the educational characteristics of the respondents are also part of the picture of this study. Most of the respondents had their last education at the elementary school level, while some others were at the high school to college level. Based on the findings of the study, both respondents with low and higher education showed limited understanding of the complications of DM. Before active leg stretching interventions were given, most respondents did not understand the process of DM complications and their prevention measures, and only a few knew that diabetic leg injuries were one of the serious complications. This data provides an additional picture of the respondents' knowledge profile without being intended to show the influence of education level on foot sensitivity.

This is in line with research conducted by Mamangkey, Kapantow & Ratag (2014) that individuals with higher education backgrounds do not always show good concern for their health conditions. Some of them tend to neglect health aspects due to the demands of work and busy activities. These conditions can trigger lifestyle changes, unbalanced diets, and reduced physical activity, which ultimately increases the risk of various complications, one of which is diabetic neuropathy. (Amalia Ayu, 2023)

After being given a brief education about active leg stretching that can be done independently at home and the importance of physical activity to prevent complications of DM, especially diabetic neuropathy, the posttest results showed that most of the respondents already understood the importance of doing physical activity independently. What's more, active leg stretching is classified as a form of exercise that is easy to do without the need for additional exercise aids.

Based on the results of the study, there were 41 respondents who had suffered from DM for less than 5 years and 9 respondents who had suffered from DM for more than 5 years. The data on the length of suffering from DM is part of the description of respondents' characteristics. Although theoretically the duration of the disease is related to the risk of complications, in this study no bivariate relationship test was conducted, so the data was only used to describe the characteristics of the respondents.

The length of time a person suffers from DM is closely related to quality of life and the risk of complications, both acute and chronic. The longer the patient experiences DM with uncontrolled hyperglycemia conditions, the greater the risk of various health problems and the possibility of serious complications. (Muzhaffarah et al., 2024)

Based on the results of the discussion of DM patients who are positive, there is a decrease in neuropathy or sensitivity of the legs due to several characteristics of the respondents in the study. This is also in line with research that neuropathy is one of the most common chronic complications of DM. This complication occurs due to poorly controlled blood glucose levels. The symptoms of peripheral neuropathy vary widely, ranging from no complaints to the onset of severe pain. The clinical manifestations that appear depend on the size and function of the damaged nerve fibers. This damage can affect the sensory, motor, or autonomic nervous systems. Jasmine Putri & Hasneli (2020)

Based on an epidemiological study conducted by , it was explained that the increased risk of diabetic neuropathy is influenced by a lack of physical activity. In addition, age factors, low glycemic control, lack of knowledge about the prevention of DM complications, and the length of time you have DM are important risk factors. Rahman et al., (2025)

Effect of Foot Sensitivity Level of Type 2 DM Patients Before and After Active Leg Stretching Intervention

The results of the statistical test using the Wilcoxon Signed Rank Test showed a significant difference between the sensitivity score of the foot using a monofilament measuring device before and after the active stretching intervention was given ($Z = –6.782$; $p = 0.000$). A total of 46 respondents experienced an increase in monofilament values (positive ranks), no respondents experienced a decrease, and 4 respondents had a fixed score. These results show that physical activity exercises such as active leg stretching are able to improve foot sensitivity in most patients with type 2 DM.

Regular moderate-intensity physical exercise can help prevent and slow metabolic disorders in people with DM, although it does not completely restore cell β pancreatic function. Physical activity is an important pillar in managing DM because it plays a role in controlling blood glucose levels and preventing complications. (Lestari & Mundriyastutik , 2023)

Diabetic neuropathy is a chronic complication of DM characterized by decreased sensation or sensitivity of the legs due to peripheral nerve damage. This condition can cause the patient to not feel any wounds or pressure in the legs that are at risk of becoming a diabetic ulcer. Therefore, physical activity is needed that can prevent foot sensitivity disorders. Active Susanti Crab et al., (2025) stretching

exercises or diabetic foot exercises have been proven to be effective in preventing decreased sensitivity in people with DM. Based on the journal "The Effect of Diabetic Foot Gymnastics on Foot Sensitivity in Type 2 DM Patients" e-Journal of Klabat University, (2025), diabetic foot gymnastics has a positive effect on increasing foot sensitivity in type 2 DM patients. Stretching and contraction of muscles during foot exercises improves peripheral blood flow and nerve oxygenation, thereby aiding in the restoration of sensory nerve function in diabetic neuropathy. (Susanti Crab et al., 2025)

The increased sensitivity of the legs is in line with the theory that active stretching increases blood flow to the lower extremities, improves peripheral nerve function, and reduces symptoms of sensory neuropathy. Stretching activities trigger repetitive muscle contractions and relaxation so as to increase circulation and oxygenation of nerve tissue in the lower limbs. This increased perfusion plays a role in improving the conduction of sensory impulses in patients with diabetic neuropathy. Widiyono et al., (2022) (Thomas et al., 2024)

These findings are in line with the research of Binarti Dwi Wahyuningsih and Umi Azizah Kusumaningrum who reported an increase in foot sensitivity after Range Of Motion training in type 2 DM patients with a 10 g monofilament test. Similar results were also found by those who stated that regular exercise of the leg muscles can improve microblood flow and lower the risk of diabetic neuropathy in DM patients. Dwi Wahyuningsih & Kusumaningrum , (2021) (Setyani & Setyoningrum , 2024)

The results of a study conducted by Priyanto, Sahar, and Widyatuti, (2023) show that there is a significant effect of foot gymnastics on foot sensitivity in DM patients. After the intervention, the sensitivity of the legs increased significantly compared to before the intervention. Research conducted by (Margaretta) also supports this finding, where diabetic foot exercises have been proven to be effective in increasing the sensitivity of diabetic feet with a p-value of 0.007. Furthermore, research by Brahmantia reinforces similar results that foot gymnastics has a noticeable effect on improving foot sensitivity in people with DM. Thus, simple physical exercises such as foot exercises or (Lestari & Mundriyastutik , 2023) active stretching can be used as an effective nonpharmacological intervention in the management of DM.

According to Tran and Haley (2021), foot exercises increase blood flow and improve circulation, this activity also increases capillary recruitment which contributes to increased insulin sensitivity. The results showed that foot exercises had a significant effect on reducing blood sugar levels, with variations in changes according to age groups. Foot exercises can be done independently by DM sufferers and healthy individuals as an effort to prevent diabetic foot injuries and improve lower extremity circulation. Squirt et al., (2025)

CONCLUSION

Before the active leg stretching intervention , all respondents (100%) showed decreased leg sensitivity. After the intervention, most respondents (92%) experienced increased sensitivity. These findings show a positive change in the sensitivity of the feet of type 2 DM patients at the Tilongkabila Health Center after active leg stretching.

Based on the results of the Wilcoxon Signed Rank Test, there was a significant difference between the pretest and posttest values of foot sensitivity ($p < 0.05$). Thus, active leg stretching has been proven to be effective in increasing the sensitivity of the feet of type 2 DM patients at the Tilongkabila Health Center.

ADVICE

For Puskesmas

The results of this study are expected to be a reference for the Tilongkabila Health Center, Bone Bolango Regency in understanding the effect of active leg stretching on foot sensitivity in type 2 DM patients. These findings may also support periodic monitoring to prevent diabetic foot ulcers.

For Patients

Patients with DM are expected to understand the benefits of active stretching or diabetic foot exercises and apply it as complementary therapy to lower blood sugar levels. Thus, complications such as diabetic foot ulcers that have the potential to cause amputation can be prevented.

For the next researcher

This study is expected to expand knowledge about foot sensitivity in type 2 DM patients and demonstrate the effectiveness of active leg stretching interventions. These findings can be the basis for future research. The researchers also suggested that the next study involve a control group so that the effect of active stretching on increasing foot sensitivity can be assessed more objectively.

BIBLIOGRAPHY

Dwi Wahyuningsih, B., & Kusumaningrum, U. A. (2021a). Increased Leg Sensitivity with Range of Motion Diabetic Exercise in Patients with Type II Diabetes Mellitus. EDUNursing Journal, 5(2). http://journal.unipdu.ac.id

Dwi Wahyuningsih, B., & Kusumaningrum, U. A. (2021b). Increased Leg Sensitivity with Range of Motion Diabetic Exercise in Patients with Type II Diabetes Mellitus. EDU Journal of Nursing, 5(2). http://journal.unipdu.ac.id

Erdaliza, E., Mitra, M., Rany, N., Harnani, Y., & Rienarti Abidin, A. (2024). Risk factors associated with complications of Type 2 Diabetes Mellitus. Journal of Community Health, 10(3), 534–545. https://doi.org/10.25311/keskom.vol10.iss3.2039

Ervanti, Y., Puspitasari, Y., & Melda, B. (2023). J u r n a l k e p e r a w a t a n m u h a m m a d i y a h The effect of resistance exercise on the value of the ankle brachial index and the decrease in blood glucose levels in patients with type 2 diabetes mellitus in the working area of the Poncokusumo Health Center in Malang. In Muhammadiyah Nursing Journal (Vol. 8, Issue 4).

Fitriani, F., Fadilla, R., & Undergraduate Study of Nursing STIKES Mitra Adiguna Palembang Kenten Permai Blok Complex, P. J. (2020). The effect of diabetic gymnastics on reducing blood sugar levels in patients with diabetes mellitus. In Journal of Health and Development (Vol. 10, Issue 19).

Florenza Laowo, D., Batubara, K., Nursing, D., Kesdam Nursing, A. I., & Medan, B. (2021). Health Education About Treatment of Foot Wounds in Type 2 Diabetes Mellitus Patients. 2(2), 68–73. https://doi.org/10.36590/v2.i2.183

Herni, H., Syahruddin, S., & Mappanyukki, A. A. (2022). The Effectiveness of Diabetic Gymnastics Exercises on Lowering Blood Glucose. Physical Activity Journal, 4(1), 135. https://doi.org/10.20884/1.paju.2022.4.1.6396

IDF. (2024). International Diabetes Federation.

Indarti, E. T., & Palupi, H. (2020). Foot Exercises are more effective in improving blood circulation to the legs than reducing glucose levels in patients with diabetes mellitus in the work area of the rejoso health center.

Joko Waluyo, S., Nur Solikah, S., DIII Nursing, P., & Insan Husada Surakarta, A. (2020). The effect of diabetic gymnastics on reducing blood sugar levels at the Mboga Sukoharjo Primary Clinic. In the Scientific Journal of Nursing (Vol. 8, Issue 2).

Lestari, D. T., & Mundriyastutik, Y. (2023a). Motivation for physical exercise in people with diabetes mellitus. In Journal of Nursing and Midwifery (Vol. 14, Issue 1).

Lestari, D. T., & Mundriyastutik, Y. (2023b). Motivation for physical exercise in people with diabetes mellitus. In Journal of Nursing and Midwifery (Vol. 14, Issue 1).

Maugeri, G., D'Agata, V., Trovato, B., Roggio, F., Castorina, A., Vecchio, M., di Rosa, M., & Musumeci, G. (2021). The role of exercise on peripheral nerve regeneration: from animal model to clinical application. Helion, 7(11). https://doi.org/10.1016/j.heliyon.2021.e08281

Melati Putri, A., & Hasneli, Y. (2020). Factors Affecting the Severity of Peripheral Neuropathy in Patients with Diabetes Mellitus : Literature Review Factors Associated of Severity of Peripheral Neuropathy Among Diabetes Mellitus Patients: Literature Review.

Murtiningsih, M. K., Pandelaki, K., & Sedli, B. P. (2021). Lifestyle as a Risk Factor for Type 2 Diabetes Mellitus. https://doi.org/10.35790/ecl.9.2.2021.32852

Muthmainnah, A., Fujiko Said, M. M., Nulanda, M., Millaty Halifah Dirgahayu Lantara, A., Safei, I., Sina YW-UMI, I., & Makassar, K. (2025). The relationship between physical activity and blood sugar levels in women of childbearing age. In August (Vol. 12, Issue 8). http://ejurnalmalahayati.ac.id/index.php/kesehatan

Muzhaffarah, S. F., Simamora, R. S., Program, R., Nursing, S. I., High, S., & Health, I. (2024). The relationship between family support and blood sugar control adherence in people with diabetes mellitus (DM). http://jurnal.globalhealthsciencegroup.com/index.php/JPPP

Nascimento Folha, P., P. F. Bacurau, R., S. Aoki, M., & Massa, M. (2024). Effect of active static stretching on glycemia in type 2 diabetes. Manual Therapy, Posturology & Rehabilitation Journal, 22. https://doi.org/10.17784/mtprehabjournal.2024.22.1308

By Kadek Yuni Lestari, I. G. A. P. S. L. (2020). Physical Activity with Blood Sugar Levels in Type 2 Diabetes Mellitus Patients. www.stikes-khkediri.ac.id

Nora, P., Gultom, N., Harahap, F., Edi, S., & Sipahutar, H. (2025). The Relationship Between Sex and Age in Diabetes Mellitus at the Medan City Health Center in 2024-2025. BIOSHELL JOURNAL, 14(1), 142–150. https://doi.org/10.56013/bio.v14i1.3960

Nuraisyah, F., Ruliyandari, R., & Matahari, R. (2021). Family History of Type II Diabetes with Blood Sugar Levels. Journal of Midwifery and Nursing Aisyiyah, 16(2), 253–259. https://doi.org/10.31101/jkk.1356

Pratama, K., Kardiatun, T., Amrullah, S., Pradika, J., Paramitha, N., Ikhwan, M., Program, S., Nursing, S., Technology, I., Muhammadiyah, K., Barat, K., Sungai, J., & Dalam, R. (2024). Implementation of video-based diabetic foot assessment and treatment protocols. http://jurnal.globalhealthsciencegroup.com/index.php/JPM

Rahman, T., Suhendro, P., Nindawi, N., & Mufidah, M. (2025). Microvascular Complication Analysis: Differences in Neuropathy in Patients with Diabetes Mellitus Who Are Treated Regularly and Who Are

Not Regular. Malahayati Nursing Journal, 7(11), 5074–5086. https://doi.org/10.33024/mnj.v7i11.21458
Rahmawati, S. E., & Gati, N. W. (2025). Application of Range of Motion (ROM) Active Legs to Improve Stiff Sensitivity in Patients with Diabetes Mellitus. https://journal-mandiracendikia.com/jikmc
Rizky Rohmatulloh, V., Pardjianto, B., Sekar Kinasih, L., Doctor Education Studies, P., Medicine and Health Sciences, F., & Islam Maulana Malik Ibrahim Malang, U. (2024). The relationship between age and sex to the incidence of type 2 diabetes mellitus based on 4 diagnosis criteria at the Internal Medicine Polyclinic of Karsa Husada Hospital, Batu City. 8(1).
Setyani, D., & Setyoningrum, U. (2024). Indonesian Journal of Nursing Research (IJNR) Differences in Signs of Diabetic Peripheral Neuropathy Before and After Diabetic Foot Exercises in Type 2 DM Patients in Nglorog Village. In Umi Setyoningrum umi_setyoningrum@yahoo.com Indonesian Journal of Nursing Research (Vol. 7, Issue 1). http://jurnal.unw.ac.id/ijnr
Sriyati. (2024). Scientific Journal of STIKES Yarsi Mataram: Diabetic Neuropathy as a Predisposing Factor for Leg Injuries: Vol. XIV (Issue 1). http://journal.stikesyarsimataram.ac.id/index.php/jik
Susanti Papuke, S., Irbar, I., Nursing, J., & Ministry of Health Gorontalo, P. (2025). Effect of diabetic foot gymnastics on foot sensitivity with Ipswich Touch Test (IPTT) measurement.
Tarigan, A. R., Nainggolan, E., Saragih, N. P., Laily, E. I., Basri, & Rinawati. (2025). The Effect of Foot Exercises on Foot Sensitivity in People with Type II Diabetes Mellitus. Indonesian Online Journal of Nursing, 7(2), 88–94. https://doi.org/10.51544/keperawatan.v7i2.5463
Thomas, E., Ficarra, S., Nakamura, M., Drid, P., Trivic, T., & Bianco, A. (2024). The Effects of Stretching Exercise on Levels of Blood Glucose: A Systematic Review with Meta-Analysis. In Sports Medicine - Open (Vol. 10, Issue 1). Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1186/s40798-023-00661-w
Ustadiyah, M., Widianti, E., Setyarini, A., Study Program,), Malang, K., Nursing, J., Health, P., & Malang, K. (2024). Implementation of diabetic foot gymnastics exercises to increase the sensitivity of the feet of patients with type 2 diabetes mellitus. Journal of Nursing Widya Gantari Indonesia, 8(3). https://doi.org/10.52020/jkwgi.v8i3.8579
Vanny Damanik, I. R. B. S. R. L. E. A. Elv. F. M. S. (2024). Effect of Active Leg Stretching on Reducing Blood Glucose Levels in Patients with Diabetes Mellitus. In January (Vol. 4, Issue 1).
WHO. (2024). World Health Organization.
Widiyono, Suwarni, A., & Aryani, A. (2022a). Provision of diabetic foot exercises on the sensitivity of the feet of type ii dm patients in Mulyorejo Village, Kalijirak, Tasikmadu, Karanganyar. Health Information and Promotion, 1(1), 37–46. https://doi.org/10.58439/ipk.v1i1.6
Widiyono, Suwarni, A., & Aryani, A. (2022b). Provision of diabetic foot exercises on the sensitivity of the feet of type ii dm patients in Mulyorejo Village, Kalijirak, Tasikmadu, Karanganyar. Health Information and Promotion, 1(1), 37–46. https://doi.org/10.58439/ipk.v1i1.6
Widyadhari Damayanti, V., Yonata, A., & Kurniawaty, E. (2023). Evi Kurniawaty | Hypertension in Diabetes Mellitus: Pathophysiology and Medulla Risk Factors | (Vol. 14, Issue 1).
Yahaya, J. J., Doya, I. F., Morgan, E. D., Ngaiza, A. I., & Bintabara, D. (2023). Poor glycemic control and associated factors among patients with type 2 diabetes mellitus: a cross-sectional study. Scientific Reports, 13(1). https://doi.org/10.1038/s41598-023-36675-3
Yang, Y., Zhao, B., Wang, Y., Lan, H., Liu, X., Hu, Y., & Cao, P. (2025). Diabetic neuropathy: cutting-edge research and future directions. In Signal Transduction and Targeted Therapy (Vol. 10, Issue 1). Springer Nature. https://doi.org/10.1038/s41392-025-02175-1
Yudha Chrisanto, E. (2020). Self-management behavior with the incidence of diabetic ulcers in patients with type 2 diabetes mellitus (Vol. 14, Issue 3).
Yulia, H., 1□, R., & Cahyati, W. H. (2022). 350 HIGEIA 6 (3) (2022) HIGEIA Journal Of Public Health Research And Development Incidence of Diabetes Mellitus at Productive Age at the Pasar Rebo District Health Center Abstract. https://doi.org/10.15294/higeia.v6i3.55268
Zhu, J., Hu, Z., Luo, Y., Liu, Y., Luo, W., Du, X., Luo, Z., Hu, J., & Peng, S. (2024). Diabetic peripheral neuropathy: pathogenetic mechanisms and treatment. Frontiers in Endocrinology, 14. https://doi.org/10.3389/fendo.2023.1265372