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The Effect of Range of Motion (ROM) Exercises on the Occurrence of Neuropathy and Angiopathy

Harry Permana Wibowo[1], Basri[2]
[1]*Faculty of Health Sciences, Undergraduate Program in Nursing, Institut Kesehatan Sumatera Utara, Medan*
[2]*Faculty of Nursing and Midwifery, Universitas Prima Indonesia, Medan*
**E-mail: harrypermanawibowo@gmail.com*

ABSTRACT

Ankle ROM training involves two movements: dorsiflexion and plantarflexion, which enhances calf muscle strength and pumping, facilitating venous return and reducing oxygen and nutrient diffusion, thus promoting overall health. This study provides active lower ROM intervention to diabetes mellitus patients twice a day for 6 consecutive days simultaneously. This type of research uses quasi-experimental research using two groups pretest-posttest, namely an experimental design where there are control and intervention groups. The samples in this study were 35, of which 17 samples were for the intervention group and 18 samples were for the control group. The research found that ankle ROM exercises significantly improved the DNE score and ABI value in both the intervention and control groups, with a statistical test result of p = 0.000 in the DNE score. It can be believed that there is a significant difference between the DNE scores of the intervention group, and the control group after doing ankle ROM exercises (p = 0.000), then H0 was rejected or there was an effect of ROM exercises on reducing the risk of neuropathy. Meanwhile, the ABI value showed a statistical test result of p = 0.002 and it can be believed that there is a significant difference between the ABI values of the intervention group and the control group after ankle ROM exercises (p = 0.002), so H0 is rejected or there is an effect of ROM exercises on reducing the risk of Angiopathy.

Keywords: range of motion, exercises, diabetes mellitus

INTRODUCTION

Diabetes Mellitus (DM) is a group of metabolic diseases characterized by high blood glucose levels due to abnormalities in insulin secretion and action. Individuals with DM face increased risks of severe health problems, high medical costs, decreased quality of life, and increased mortality rates, requiring urgent medical attention (Agustina et al., 2019). Diabetes mellitus is a significant public health issue, ranking among the four priority non-communicable diseases. Patients experience various issues, including peripheral neuropathy, which is a condition affecting the immune system and nervous system (Djamaludin et al., 2019).

DM is one of the diseases that cannot be cured so sufferers require medical treatment in the form of dietary regulation, regular lifestyle, and medical therapy. Medical care, especially poor food quality in people with diabetes, can lead to complications such as coronary artery disease and peripheral blood vessels, stroke, diabetic nephropathy, amputation, kidney failure, and blindness. Complications of the disease in people with diabetes can reduce the quality of life

of sufferers and even result in death. Not only sugar consumption, but consumption of other nutrients such as fat, fiber, antioxidants, and others also greatly affect the development of DM. (Sa'pang et al., 2021).

Based on the International Diabetes Federation (IDF, 2019), the number of cases of DM sufferers in the world is increasing every year. In 2017 there was an increase of 425 million people, and in 2019 it increased by 463 million people with a diabetes rate of 9.0% in women and 9.6% in men. Meanwhile, it is estimated that in 2030 it will increase to 578 million people, and in 2045 the incidence is estimated to continue to increase to reach 700 million people who will be diagnosed with DM. Indonesia is ranked 7th for DM sufferers in 2019 after China, India, America, Brazil, and Mexico, which is 10.7 million people. The International Diabetes Federation predicts a 16.6 percent increase in diabetes incidence by 2045, with China, India, and the US being the top countries with the most sufferers.

World Health Organization (WHO) in 2000 estimated that there would be an increase in DM sufferers in Indonesia, namely from 8.4 million cases to 21.3 million cases in 2030. Indonesia's diabetes mellitus prevalence has increased from 6.9% to 8.5%, with 12,191,564 affected (Riskesdas, 2018). Diabetes prevalence in Indonesia was 1.5% for all ages, slightly lower than for those aged 15 or older. DKI Jakarta had the highest prevalence based on medical diagnosis, while NTT had the lowest. The majority of diabetics were aged 55-64 and 65-74, with 1.8% more than men. Urban areas had the highest prevalence of diabetes, with 1.9% more than rural areas (Kementerian Kesehatan RI, 2019).

Diabetes causes significant economic losses for individuals, families, health systems, and national economies through direct medical costs, job loss, and income loss. It is also a leading cause of kidney disease, blindness, amputations, disability, and even death in people under 65 years old (Tanzila et al., 2020). Diabetes mellitus patients often experience decreased sensitivity in their feet, a sensory receptor sensitive to touch, temperature, pressure, and pain. Nerve disorders, such as diabetic neuropathy, can manifest in various forms, including numbness and ulcers on the feet. Neuropathy can impact insensitivity or loss of feeling by inhibiting signals and stimuli, breaking down communication in the body (Wardani et al., 2019).

Diabetes mellitus sufferers who experience diabetic neuropathy are 25% in the world. While in Indonesia, diabetes mellitus sufferers who experience diabetic neuropathy reach 54% (Mutiara et al., 2023). It is estimated that 19-34% of diabetes patients are likely to experience

diabetic ulcers in their lifetime. The International Diabetes Federation (IDF) reports that 9.1–26.1 million DM sufferers have the potential to experience diabetic ulcers each year (Everett & Mathioudakis, 2018).

The prevalence of diabetic ulcers reaches in Indonesia 15-25% in DM sufferers and as many as 5-7.5% of patients experience neuropathy per year (Sukartini et al., 2020). Basic Health Research Data (Riskesdas, 2018) states that the prevalence of diabetes mellitus in Indonesia who suffer from diabetic ulcers is 849 people. This number is predicted to continue to increase along with the increasing number of diabetes sufferers. The North Sumatra Provincial Health Data Report shows that the prevalence of diabetes mellitus with complications of diabetic ulcers in North Sumatra Province is 3,400 people (Kementerian Kesehatan RI, 2020).

Diabetes management in Indonesia, particularly among the elderly, involves counseling, meal planning, education, medical nutrition therapy, physical exercise, and pharmacological therapy to improve insulin function and reduce weight (Masnah, 2021). Diabetes mellitus can lead to nerve damage, affecting foot sensitivity and potentially causing serious complications like wounds and ulcers on the feet (Simanjuntak et al., 2020). Foot gymnastics can improve blood circulation, increase foot sensitivity, and prevent peripheral nerve damage in diabetic patients by preventing injury and reducing complications (Megawati et al., 2020).

In addition to foot exercises, there are various types of physical exercises for DM sufferers in relation to foot sensitivity, namely isometric and isotonic muscle contraction exercises, strength training, aerobic exercise, and range of motion exercises. Lukita et al., (2018) stated that active ROM of the feet can improve blood circulation and reduce blood sugar levels to increase foot sensitivity. The benefits of ROM exercises extend beyond just the prevention of complications. They have been shown to enhance muscle strength and joint function, which are crucial for maintaining mobility in diabetic patients (Faridah et al., 2022). Moreover, ROM exercises can also facilitate better blood flow, which is essential for preventing angiopathy, as they stimulate the vascular system and promote endothelial function (Maula et al., 2024).

Based on a preliminary survey, data on DM patients from 2022 to 2023 continued to increase. From October to November 2023, DM data at the Medan Tuntungan Health Center was 55. Researchers found that most DM sufferers who visited the Medan Tuntungan Health Center experienced symptoms of neuropathy and angiopathy which were characterized by several complaints such as frequent numbness/tingling in the feet, decreased sensitivity in the foot area, and frequent complaints of pain. Some sufferers said it was difficult to do activities such as

working and they were very disturbed by the symptoms of the disease they felt. Based on this, researchers are very interested in research with the aim of finding out the effect of ROM training on preventing neuropathy and angiopathy in DM sufferers in the Medan Tuntungan Community Health Center Area.

METHODS

This study uses a quantitative, quasi-experimental design with a pre-post test control group design. The control group was assessed using the ABI and Scoring DNE instruments without intervention, while the intervention group was assessed before and after the ROM application on the ankle. Quantitative research is based on positivistic data, measured as numbers, to produce a conclusion related to the problem being studied. The location of this research is the UPTD Tuntungan Health Center, Medan Tuntungan District, Medan City. The research began in February 2024 to July 2024.

This study surveyed 55 diabetic patients at Medan Tuntungan Health Center between October and November 2023. The sample was selected using the Purposive Sampling technique, which considers the characteristics of the sample. The patients were included as having diabetes for at least a year, aged 40 or older, without lower limb paralysis, neuropathy or angiopathy, or no DM ulcers. The study excluded non-ulcer type 2 diabetic patients with decreased consciousness, limited physical mobility, joint disorders, or diabetic ulcers. Samples were taken be using the Purposive Sampling technique with a sample size of 35.

Diabetic Neuropathy Examination (DNE) detects sensory neuropathy symptoms in diabetics with high sensitivity (96% and specificity 51%), detecting abnormal responses when vibration sensations are absent (Jayaprakash & Anupriya, 2018). The Ankle Brachial Index (ABI) measures angiopathy by comparing systolic blood pressure at the ankle with the brachial artery, with a normal ABI indicating effective blood flow to the periphery (Simanjuntak et al., 2020).

The research hypothesis was tested through data analysis, including a Univariate analysis comparing pre-test and post-test results, and a Bivariate analysis using a paired t-test to measure the relationship between variables, specifically examining the effect of Range of Motion exercises on neuropathy and angiopathy in Diabetes Mellitus patients.

RESULTS

Respondent Demographic Data

The frequency distribution of respondents can be seen in the table below:

Table 1. Frequency Distribution of Characteristics of Intervention Group Respondents

Characteristics	Frequency (f)	Percentage (%)
Age		
35-50	4	23.5
>50	13	76.5
Gender		
Male	7	41.2
Woman	10	58.8
Education		
Elementary, Middle, and High School	8	47.1
Bachelor (S1, S2, S3)	9	52.9
Work		
Housewife	5	29.4
civil servant	4	23.5
Farmer	3	17.6
Self-employed	5	29.4

Based on Table 1, it can be seen that in the intervention group, the majority of respondents' ages were 35-50 years old, 4 respondents (23.5%), and the majority of aged >50 years were 13 respondents (76.5%). Gender were male 7 respondents (41.2%), while women were 10 respondents (58.8%). Education was elementary school, junior high school, and high school, 8 respondents (47.1%), Bachelor's degree (S1, S2, S3) 9 respondents (52.9%). Occupations were housewives 5 respondents (29.4%), civil servants 4 respondents (23.5%), farmers 3 respondents (17.6%), and self-employed 5 respondents (29.4%).

Table 2. Frequency Distribution of Characteristics of Respondents in the Control Group

Characteristics	Frequency (f)	Percentage (%)
Age		23.5
35-50	4	76.5
>50	13	
Gender		
Man	14	77.8
Woman	4	22.8
Education		
Elementary, Middle, and High School	13	72.2
Bachelor (S1, S2, S3)	5	27.8
Work		
Housewife	0	0.0

Characteristics	Frequency (f)	Percentage (%)
Civil servant	4	22.2
Farmer	9	50.0
Self-employed	5	27.8

Based on Table 2, it can be seen that in the control group, the majority of respondents ages were 35-50 years old, 5 respondents (27.8%), and the majority of respondents aged >50 years were 13 respondents (72.2%). Gender were male 14 respondents (77.8%), while women were 4 respondents (22.2%). Education was elementary school, junior high school, or high school, 13 respondents (72.2%), Bachelor's degree (S1, S2, S3) 5 respondents (27.8%). Occupations were housewives, there were no respondents (0%), civil servants 4 respondents (22.2%), respondents were farmers, 9 respondents (50.0%), and respondents were self-employed 5 respondents (27.8%).

Neuropathy Values Before (Pre) and After (Post) in the Intervention Group

Based on the data, the neuropathy values were obtained as follows:

Table 3. Neuropathy and Angiopathy Values Before (Pre) and After (Post) in the Intervention Group

Neuropathy	Frequency (f)	Percentage (%)
Pretest		
4-6 (Medium)	17	100.0
Posttest		
1-3 (Light)	7	41.0
4-6 (Medium)	10	59.0
Angiopathy	**Frequency (f)**	**Percentage (%)**
Pretest		
0.70-0.90 (Light)	17	100.0
Posttest		
0.70-0.90 (Light)	17	100.0

Based on the Table 3, the neuropathy values before (pre) and after (post) in the intervention group have different values where the number of intervention groups is 17 and the values before (pre) are obtained with a range of values 4-6 with a moderate category of 17 respondents. The value after (post) is obtained with a range of values 1-3 with a "mild" category of 7 respondents and a range of values 4-6 with a "moderate" category of 10 respondents. The angiopathy values before (pre) and after (post) in the intervention group have the same value where the number of control groups is 17 and the values before (pre) and after (post) are obtained from the research, namely a range of values 0.70-0.90 with a mild category.

Table 4. Neuropathy and Angiopathy Values Before (Pre) and After (Post) in the Control Group

Neuropathy	Frequency (f)	Percentage (%)
Pretest		
4-6 (Medium)	18	100.0
Posttest		
4-6 (Medium)	18	100.0
Angiopathy	**Frequency (f)**	**Percentage (%)**
Pretest		
0.70-0.90 (Light)	18	100.0
Posttest		
0.70-0.90 (Light)	18	100.0

Based on the Table 4 above, the neuropathy values before (pre) and after (post) in the control group have the same value where the number of control groups is 18, and the values obtained before (pre) and after (post) the study was conducted, namely the range of values 4-6 with a moderate category. The angiopathy values before (pre) and after (post) in the control group have the same value where the number of control groups is 18 and the values obtained before (pre) and after (post) the study was conducted, namely the range of values 0.70-0.90 with a mild category.

Neuropathy Values and Angiopathy Values before (Pre) and after (Post) Range of Motion (ROM) Exercise in the Control and Intervention Groups

Data related to neuropathy and angiopathy values before (pretest) and after (posttest) Range of Motion (ROM) exercises are shown in the table below:

Table 5. Distribution of Average Neuropathy and Angiopathy Values Before and After Range of Motion (ROM) Exercise in the Intervention Group

Neuropathy	N	Mean	P-Value
Pretest	17	4.88	0.00
Posttest	17	3.65	
Angiopathy	**N**	**Mean**	**P-Value**
Pretest	17	0.84	0.002
Posttest	17	0.87	

Based on the table, the average neuropathy value before treatment was 4.88, and after treatment was 3.65. The results showed a difference in values that showed a significant meaning which means a decrease in the risk of neuropathy. The results of the study obtained a P-value = 0.00 ($p < 0.05$), this means that the use of the t-test has a significant effect.

The average angiopathy value before treatment was 0.83 and after treatment was 0.86. The results showed a difference in values that showed a significant meaning, meaning that there

was a decrease in the risk of angiopathy. The results of the difference test obtained P-value = 0.002 (p <0.05), this means that the use of the t-test has a significant effect.

Table 6. Distribution of Average Neuropathy and Angiopathy Values in the Control Group Without Intervention Before and After the Study

Neuropathy	N	Mean	P-Value
Pretest	18	4.89	0.579
Posttest	18	4.94	
Angiopathy	**N**	**Mean**	**P-Value**
Pretest	18	0.84	0.024
Posttest	18	0.82	

Based on the Table 6, the neuropathy score in the control group was assessed using DNE scoring without intervention, which was 4.89 and 4.94. The results showed a difference in values that showed a significant meaning, meaning there was no decrease in the risk of neuropathy. The results of the difference test obtained a P-value = 0.579 (p> 0.05), this means that there is no significant effect on the DNE score in the control group.

The mean angiopathy values were 0.84 and 0.82. The results showed a difference in values that showed a significant meaning, meaning there was no decrease in the risk of angiopathy. The results of the difference test obtained a P-value = 0.024 (p> 0.05), this means that there is no significant effect on the angiopathy value in the control group.

DISCUSSION

Neuropathy and Angiopathy Occurrence Before and After Range Of Motion Exercises

Ankle ROM exercises are movements that include 2 movements, namely dorsiflexion and plantarflexion which result in increased calf muscle strength and increased calf muscle pumps to facilitate venous return which has a positive impact on reducing the diffusion of oxygen and nutrients (Djamaludin et al., 2019). Based on research Lestari and Z.R (2022) by providing active lower ROM intervention in Diabetes Mellitus patients, it was carried out 2 times a day for 6 consecutive days simultaneously. Statistically, there was an effect on ABI and DNE values before and after the active lower ROM intervention was given. This is because, during the study, respondents were able to comply with the procedures set by the researcher, where respondents followed the active lower ROM intervention 2 times a day for 6 consecutive days at the same time.

Neuropathy Values Before (Pre) and After (Post) in the Intervention Group

The neuropathy values before (pre) and after (post) in the intervention group have different values where the number of intervention groups is: 17 and the values before (pre) are obtained

with a range of values 4-6 with a moderate category of 17 respondents. The value after (post) is obtained with a range of values 1-3 with a mild category of 7 respondents and a range of values 4-6 with a moderate category of 10 respondents. This shows a significant change before and after being given treatment, seen in the range of values, namely before being given treatment 17 respondents were found to have moderate neuropathy (4-6) and after being given treatment, there were 7 respondents with a mild neuropathy category (1-3) and the remaining 10 respondents with a moderate neuropathy category (4-6). This is because effective movement is given to make blood circulation smooth so that the flow of the nervous system is not disturbed.

Angiopathy Values Before (Pre) and After (Post) in the Intervention Group

The angiopathy value before (Pre) and after (Post) in the intervention group had the same value where the number of control groups was 17 and the value obtained before (Pre) and after (Post) the study was conducted, namely a range of 0.70-0.90 with a mild category. The reduction in the risk of angiopathy was measured by comparing ankle systolic pressure and brachial systolic pressure. The easiest tool to measure blood pressure today is to use a Spygnomanometer in the treatment group before and after leg exercises.

Neuropathy Values Before (Pre) and After (Post) in the Control Group

The neuropathy values before (PRE) and after (POST) in the control group were the same where the number of control groups was 18 and the values obtained before (Pre) and after (Post) the study was conducted were in the range of 4-6 with a moderate category. This is because the control group was not given intervention so there was no significant change in the neuropathy values before and after the study. Lack of mobilization causes blood circulation, especially in the ankle area, to be irregular and forms blood clots, causing edema in the nerves so that signals to the nerves are disrupted (Djamaludin et al., 2019).

Angiopathy Values Before (Pre) and After (Post) in the Control Group

The angiopathy values before (PRE) and after (POST) in the control group were the same where the number of control groups was 18 and the values obtained before (Pre) and after (Post) were conducted, namely a range of 0.70-0.90 with a mild category. This is because the control group was not given intervention so there was no significant change in the neuropathy values before and after the study. Also, the lack of mobilization makes blood circulation not smooth and forms clots so that contractions in the muscles in the legs are reduced (Setiawati et al., 2019).

The Effect of Range of Motion Exercises on the Incidence of Neuropathy and Angiopathy in Diabetes Mellitus Patients in the Medan Tuntungan Health Center Area

The study analyzed the effect of ankle ROM exercises on neuropathy and angiopathy values in the intervention and control groups. Results showed a significant difference in angiopathy values between the intervention and control groups after ankle ROM exercises. The hypothesis (H0) was rejected, indicating that ROM exercises reduced the risk of neuropathy. However, the study did not focus on the category of the exercise, but rather on the values obtained from each measurement. The results showed differences in each variable, even in the same category, for both groups, indicating that ROM exercises may have a positive effect on reducing angiopathy.

Research indicates that regular ankle ROM exercises can significantly enhance joint mobility and muscle strength in diabetic patients, preventing neuropathy and angiopathy, emphasizing the importance of maintaining joint flexibility to prevent these complications (Djamaludin et al., 2019). Similarly, Asih reported that active ROM exercises positively influence foot sensitivity in type II diabetes patients, suggesting that such exercises can help maintain nerve function and prevent neuropathic complications (Asih et al., 2023). Furthermore, Purnamawati et al. emphasized the necessity of active ROM exercises for preserving foot sensitivity, which is crucial in preventing diabetic foot ulcers (Purnamawati et al., 2022).

Regular ROM exercises improve blood circulation, crucial for nerve health and reducing microvascular damage in diabetic neuropathy. Long-standing diabetic patients' peripheral nerves show significant microvascular pathology, indicating nerve function deficits. Physical exercise, including ROM activities, can improve blood flow and reduce ischemic damage to nerves (Stubbs et al., 2019). Additionally, the findings of Francis indicate that strengthening exercises targeting intrinsic foot muscles can improve ankle mobility and potentially alleviate symptoms of diabetic peripheral neuropathy (Francis et al., 2024).

Moreover, the role of ROM exercises extends beyond just preventing neuropathy; they also play a critical role in enhancing overall functional mobility in diabetic patients. The work by Mendonça et al. on muscle activation during different ROM conditions suggests that full ROM exercises may lead to better muscle adaptations, which can enhance functional capabilities in individuals with diabetes (Mendonça et al., 2021). This is particularly relevant as improved muscle strength and joint mobility can lead to better balance and reduced fall risk, which is crucial for the elderly diabetic population (Prókai et al., 2023).

The effectiveness of ROM exercises in improving vascular health is further supported by findings that suggest these exercises can enhance overall physical function and quality of life in patients with chronic conditions (Daneshvar et al., 2019). For instance, a study comparing different exercise modalities found that those engaging in ROM exercises experienced significant improvements in their range of motion and overall functional capabilities, which are critical for preventing secondary complications such as neuropathy and angiopathy.

CONCLUSION

A quasi-experimental study was conducted to examine the Effect of Range Of Motion (ROM) Exercise on the incidence of neuropathy and angiopathy in Diabetes Mellitus patients. Thirty-five DM patients were recruited by collecting data and then the results of the study were analyzed using the Paired T-test.

In the intervention group, there was a significant difference in DNE scores between the initial and final measurements of the study in the intervention group ($p = 0.00$). There was a significant difference in ABI values between the initial and final measurement of the study in the intervention group ($p = 0.02$). In the control group, there was no significant difference in DNE scores between the initial and final measurements of the study ($p = 0.579$), and there was no significant difference in ABI values between the initial and final measurements of the study ($p = 0.024$). There was an effect of ankle ROM training on preventing neuropathy and angiopathy, indicated by a significant difference in DNE scores between the intervention group and the control group at the end of the study $p = 0.000 < \alpha = 0.05$, and there was a significant difference in ABI values between the intervention group and the control group at the end of the study $p = 0.002$.

In conclusion, the evidence supports the notion that ROM exercises are beneficial in preventing neuropathy and angiopathy in diabetic patients. These exercises not only enhance joint flexibility and muscle strength but also improve blood circulation, thereby mitigating the risk of diabetic complications. The integration of ROM exercises into rehabilitation programs for diabetic patients is essential for maintaining their quality of life and preventing further health deterioration.

LIMITATION

The study's limitations stem from its small sample size, as patients from the UPTD Tuntungan Health Center often experience severe complications. The researchers suggest expanding the scope to include multiple Medan health centers, rather than focusing on one.

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