



THE EFFECT OF DIABETES MELLITUS EXERCISES AND NEUROMUSCULAR TAPING (NMT) ON ANKLE BRACHIAL INDEX (ABI) IN TYPE 2 DM PATIENTS

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ABSTRACT

Diabetes mellitus is caused by metabolic disorders characterized by increased blood glucose levels due to insulin secretion. Complications of peripheral arterial DM cause decreased blood flow to the lower extremities, marked by a decrease in ABI. Non-pharmacological therapy requires diabetes exercises and NMT to prevent injury to the feet due to changes in peripheral blood circulation. Objective: research to determine the effect of diabetic foot exercises and NMT on ABI in Type 2 DM patients. Method: Quantitative design, quasi-experimental method, pre-test post-test control group design, sampling technique using purposive sampling. Observations assessed the ABI score before the diabetes exercise intervention in intervention 1 and intervention 2 NMT, and group 3 control. Results: Data analysis using paired tests on ABI in 3 groups showed that in group I the foot exercise intervention resulted in p. 0.001 means there is a change in results before and after the intervention. Likewise, in group II of the NMT intervention, the result was p 0.001, there was a change in results before and after the intervention. Conclusion: Research proves that diabetes foot exercise and NMT interventions can improve ABI values in Type 2 DM patients.

Keywords: ankle brachial index; diabetes mellitus foot exercises; neuromuscular taping

First Received 20 December 2023	Revised 28 December 2023	Accepted 20 January 2024
Final Proof Received 08 February 2024		Published 20 February 2024
How to cite (in APA style) Ulkhasanah, M. E., & Widiastuti, A. (2024). The Effect of Diabetes Mellitus Exercises and Neuromuscular Taping (NMT) on Ankle Brachial Index (ABI) in Type 2 Dm Patients. Indonesian Journal of Global Health Research, 6(1), 383-390. https://doi.org/10.37287/ijghr.v6i1.2752 .		

INTRODUCTION

Diabetes mellitus is a degenerative disease with the number of sufferers continuing to increase. This disease is caused by metabolic disorders which are characterized by increased blood glucose levels due to damage to insulin secretion. International Diabetes Federation (IDF) in 2020 the prevalence of Diabetes Mellitus in the World reached 463 million people, it is estimated that in 2030 this number will continue to increase to 578 million people, in 2045 the number of Diabetes Mellitus sufferers could reach 700 million people(World Health Organization (WHO), 2020). The results of Basic Health Research in 2018 also show that the prevalence of Diabetes Mellitus in Indonesia based on diagnosis at the age of ≥ 15 years is 2%, this number continues to increase compared to the prevalence of Diabetes mellitus in the population aged ≥ 15 years in the results of the 2012 Basic Health Research with a number of 1.5% of sufferers. Diabetes Mellitus occurs if the fasting blood glucose level is more than 126 mg/dl or the temporary blood glucose level is more than 200 mg/dl. The increasing incidence of Diabetes Mellitus is followed by an increase in the incidence of both physical and psychological complications(RISKESDAS, 2018).

Diabetes Mellitus is also called the silent killer because this disease can affect all organs of the body so that it can cause various kinds of complaints. If the disease is not treated properly it will cause many complications. Hyperglycemia in type 2 Diabetes Mellitus causes microangiopathy complications, this occurs due to high blood sugar levels which cause chronic complications resulting in quite high morbidity, one of which is neuropathy and peripheral arterial disease. Neuropathy cases in Diabetes Mellitus reach 54% of 100,000 people per year (Milita et al., 2021). Complications that arise due to diabetes mellitus include peripheral arteries, which are caused by atherosclerosis in peripheral vascular disease which has an impact on decreasing blood flow to the lower extremities which is characterized by a decrease in the Ankle Brachial Index (ABI). This examination is used as a tool to detect blood flow disorders which may indicate peripheral arterial disease in Diabetes Mellitus patients which may worsen the patient's condition. A low ABI value which causes vascular disorders can be influenced by multiple factors such as the length of time the sufferer has suffered from Diabetes Mellitus, taking inappropriate anti-hyperglycemia medication, low physical activity, foot care that is not optimal and a Diabetes Mellitus diet that has not been implemented properly (Unnikrishnan et al., 2016).

Management of Diabetes Mellitus can be done with both pharmacological and non-pharmacological therapy. Non-pharmacological management includes weight control, exercise and diet, but this therapy is carried out without abandoning the pharmacological therapy that has been given. Innovative management techniques that can be used to improve the condition of Diabetes Mellitus patients with exercise. This technique is one of the efforts made to prevent, control and overcome Diabetes Mellitus. Sports exercises such as Diabetes Mellitus foot exercises are an activity of choice for patients to prevent injuries and help improve blood flow, especially to the feet. Foot exercises can improve blood circulation and strengthen the small muscles of the feet and prevent foot deformities. Leg exercises can increase the strength of the calf muscles and thigh muscles and overcome limitations in joint movement (Pratiwi, 2019). Non-pharmacological therapy management needs to be carried out in addition to Diabetes Mellitus exercises to prevent injury to the diabetic foot due to changes in peripheral blood circulation (Suryasa et al., 2021). This can be done with physiotherapy modalities such as Neuromuscular Taping (NMT). This therapy method uses decompression and compression stimulation techniques to obtain positive effects on the musculoskeletal, neurological, vascular and lymphatic systems. The innovative non-pharmacological technique used aims to prevent a decrease in peripheral blood circulation in the lower extremities. The method used is by attaching plaster to the skin which can have an extrinsic effect on the muscles thereby reducing pressure on the tissue under the skin (Susanti & Arofiati, 2022).

Neuromuscular Taping (NMT) is used to improve blood circulation, reduce edema in the lower extremities, provide stimulation to the muscles and skin, reduce pain, and can reduce symptoms that arise due to disruption of the blood vessel nervous system. This technique aims to facilitate the healing process, reduce symptoms and improve the patient's quality of life, its benefits include increasing blood circulation and stimulating neuromuscular activity. This condition occurs because the blood vessels that flow to the legs are blocked, so that the blood supply cannot reach the leg tissues. Several studies show that diabetic exercise helps increase blood flow throughout the body, including the lower extremities by reducing the risk of peripheral vascular disorders that often occur such as diabetic foot ulcers, blood circulation disorders, besides this technique improves blood circulation, insulin response and is able to control blood sugar (Rizal, 2023).

Efforts are made to detect blood flow disorders in the legs using the Ankle Brachial Index (ABI), measurements are made by the ratio of the systolic pressure in the arm to the systolic pressure in the lower leg. The results of the Ankle Brachial Index measurement show the condition of blood circulation in the lower legs with a value range of 0.9-1.3 with data showing that blood circulation to the legs is normal. Other research has also been carried out in an effort to improve the Ankle Brachial Index (ABI) value by implementing diabetic foot exercises, however research regarding the management of Neuromuscular Taping (NMT) in an effort to improve the Ankle Brachial Index (ABI) is still rarely carried out, so researchers will look at the influence of both This management is related to the Ankle Brachial Index (ABI)(Silaban et al., 2019).

METHOD

This research method uses a quantitative design with a quasi-experimental pre-test post-test method with control group design. This study used 3 groups of respondents, namely group I intervention of diabetic foot exercises, group II intervention Neuromuscular Taping (NMT), and group III standard intervention control from the health center. The independent variable in this study was Neuromuscular Taping (NMT) and Diabetic Foot Exercises, while the dependent variable was the Ankle Brachial Index (ABI). Analysis of the data used to determine the Ankle Brachial Index (ABI) before and after implementing the intervention in each group was carried out by a Pired t-test to determine the comparison before and after the intervention was given. The results of a preliminary study that was carried out were based on data obtained at the Masaran II Community Health Center, a total of 97 people suffering from Type 2 Diabetes Mellitus. The research sample using the Slovin formula calculation in each group was 27, so the total number was 81 respondents. The sampling technique uses purposive sampling. This study used sampling selection with the following criteria: cooperative patients and composmentis awareness, Diabetes Mellitus patients who undergo routine check-ups at Masaran II Health Center aged 40-75 years, suffering from Diabetes Mellitus for more than 5 years, patients do not experience diabetic ulcers and can do sports , patients who are ready to become respondents by signing a letter of consent. The exclusion criteria for this study were that patients had serious complications, symptoms of diabetic ulcers.

The standard surgical procedure is used as an intervention instrument for diabetic foot exercises, but the installation of Neuromuscular Taping (NMT) is carried out using a fan type tape as a standard surgical procedure. Evaluation to assess ABI, researchers measured the ratio of the highest systolic blood pressure at the ankle or ankle dorsalis pedis and the posterior tibia and brachial arm. Instruments used in data collection include a sphygmomanometer, stethoscope, newsprint, tape and an observation cupboard for Ankle Brachial Index values. Interpretation of ABI values: 1) 0.90-1.30 = Normal, 0.60 -0.89 = mild arterial obstruction, 0.40 - 0.59 = moderate obstruction, < 0.40 = severe obstruction. Researchers obtained permission from the Masaran II community health center to conduct research, then determined respondents based on inclusion and exclusion criteria. Before the intervention was carried out, the researcher provided informed consent to the respondents through an explanation of the research objectives, benefits and procedures. Observations were carried out by checking the Ankle Brachial Index (ABI) score both before the diabetic exercise intervention in intervention group 1 and during the Neuromuscular Taping (NMT) intervention in intervention group 2 and group 3 as control. The Neuromuscular Taping (NMT) intervention was given for one week to each respondent and the taping was changed every 3 days, while the diabetic foot exercise intervention was routinely carried out 4 times a week for 30 minutes. The aim of the research in the application of diabetic foot exercises and

Neuromuscular Taping (NMT) is to help increase the Ankle Brachial Index (ABI) value in patients with type 2 diabetes mellitus. Data were analyzed using a homogeneity test in group I of the diabetes foot exercise intervention, group II of the Neuromuscular Taping (NMT) intervention and group III of the control. The results of the homogeneous distributed data were then analyzed using paired statistical tests to determine changes or differences before and after treatment in the 3 groups.

RESULTS

The results are descriptive of the frequency distribution characteristics which include the age and gender of the respondents. These data show that in the diabetic exercise intervention group and the Neuromuscular Taping (NMT) intervention group the highest number of respondents was aged 45-59 years, while in the control group the highest number was in the 36-45 year age category. Frequency distribution by gender category in intervention group I diabetic exercise and intervention group II Neuromuscular Taping (NMT) the highest number was male, while in control group III the highest number was female.

Table 1.
Frequency Distribution of Respondent Characteristics

Respondent characteristics	Intervention group I diabetic exercise		Intervention group I NMT		Intervention group I	
	f	%	f	%	f	%
Age						
36-45 years old	4	15	8	30	13	48
45-59 years old	12	44	14	52	9	33
56-65 years old	11	44	5	19	5	19
Gender						
Male	9	33	11	41	19	70
Female	18	67	16	59	8	30

The frequency distribution of Ankle Brachial Index (ABI) scores in intervention group I and intervention group II showed that the highest Ankle Brachial Index (ABI) score was in the borderline category, while in control group III the highest was in the normal category.

Table 2.
Frequency distribution of Ankle Brachial Index ABI in Type 2 Diabetes Mellitus patients

Ankle Brachial Index ABI Category	Intervention Group NMT	Intervention Group Diabetic Exercise	Control group
Normal	8	12	14
Mild Arterial Obstruction	19	15	13

The results of the paired t-test for the diabetic foot exercise intervention group showed a value of $p = 0.001$, this result shows that there is a difference in scores before and after the diabetic foot exercise intervention.

Tabel 3.
Intervention Group I Diabetic Exercise

Ankle Brachial Index ABI Category	Mean	P	Z Score
Pre intervention	0,938	0,001	-3.272
Post intervention	1,02		

The results of the paired t-test for group II of the Neuromuscular Taping (NMT) intervention showed a p value of 0.001, this result shows that there is a difference in values before and after the intervention.

Tabel 4.
Intervention Group II Neuromuscular Taping (NMT)

Ankle Brachial Index ABI Category	Mean	P	Z Score
Pre intervention	0,674	0,004	-1,092
Post intervention	1,766		

Hasil pired t-test kelompok III kontrol menunjukkan nilai p= 0,016 hasil tersebut bahwa tidak ada perbedaan nilai sebelum maupun sesudah dilakukan pemeriksaan ABI.

Tabel 4.
Group III Control group

Ankle Brachial Index ABI Category	Mean	P	Z Score
Pre intervention	0,807	0,016	2,756
Post intervention	0.809		

DISCUSSION

Risk factors for type 2 diabetes mellitus consist of factors that can be modified and factors that cannot be modified. Age and gender are factors that cannot be modified, risk factors for Diabetes mellitus will often appear after ≥ 45 years. On average, at the age of 40, humans generally experience physiological decline more rapidly, so that various diseases often appear at the age of 40. People aged ≥ 45 years have an increased risk of developing diabetes mellitus and glucose intolerance due to degenerative factors which are characterized by a decrease in the body's function to metabolize glucose (Mekala & Bertoni, 2019). This is in accordance with several epidemiological studies which state that the level of susceptibility to contracting type 2 diabetes mellitus is in line with increasing age. As we age, the risk of diabetes increases due to decreased insulin sensitivity and decreased function of pancreatic beta cells, which are responsible for producing insulin (Milita et al., 2021).

The results of the study showed that the frequency distribution category of diabetes mellitus sufferers was dominated by women, both in intervention group I 67% and intervention group II 59%. These results show that women suffering from diabetes mellitus are more at risk, this is because physically women have a greater chance of increasing their body mass index. Previous research shows that more women are obese and are at 2.7 times greater risk of developing diabetes mellitus than men, this happens because men have more muscle mass and use it more than women. The hormones estrogen and progesterone found in women have an important role in glucose metabolism, during menstruation and pregnancy these hormone levels can fluctuate significantly which can affect insulin sensitivity and glucose metabolism. In menopausal women, there is a decrease in these hormone levels, which has an impact on glucose metabolism and increases the risk of diabetes mellitus.

Management that can be done in an effort to help and manage the risk of diabetes mellitus by adopting a healthy lifestyle such as maintaining a balanced diet, regular exercise and managing stress can increase the risk of diabetes mellitus. Someone who has diabetes mellitus needs to monitor glucose levels regularly, this action can help patients understand how to adjust their lifestyle according to their condition (Spaight et al., 2016). Diabetes mellitus patients need regular health checks, this is done to monitor complications that may arise due to diabetes mellitus. Regular health monitoring can identify health problems early and provide appropriate treatment (Lasmawati et al., 2023). Diabetes mellitus patients have the potential to suffer from various complications such as microangiopathy and neuropathy, which are disorders of the nervous system in the feet and peripheral blood flow. Strategies that can be

implemented to prevent ulcers, increased blood sugar levels and further complications in type 2 diabetes mellitus include 4 main pillars in managing diabetes mellitus, namely education, nutritional therapy, physical exercise and pharmacological intervention. Physical exercise is very important in efforts to prevent, control and overcome diabetes mellitus (Suryasa et al., 2021). One of the physical exercises that can be done is by exercising the feet using diabetic foot exercises. The aim of performing diabetic foot exercises on patients is to prevent injuries and help improve blood circulation in the feet (Reddy & Tan, 2020).

The results of research in intervention group I with diabetes foot exercises showed that the result was $p < 0.001$, which means there was a difference in the Ankle Brachial Index (ABI) value before and after diabetes mellitus foot exercises. Respondents in intervention group I who were given diabetic foot exercise treatment had higher ABI values after diabetic foot exercise training, however in control group III the ABI values measured at the same time tended to be the same, because the control group was not given special treatment, respondents were only given interventions in accordance with standard implementation from the Community Health Center. These results are in accordance with research conducted by Diyah Fatmawati in 2019 that the combination intervention of Diabetic Self Management Education (DSME) with diabetes mellitus foot exercises was effective in increasing the Ankle Brachial Index (ABI) value (Fatmasari et al., 2019). This combination therapy intervention can also reduce blood sugar levels significantly, so that diabetes foot exercises have an important role in the management of diabetes mellitus. The implementation of diabetes mellitus foot exercises is carried out in an effort to prevent complications, especially neurological, in diabetes mellitus patients by improving the blood vessel system in the feet (Resti et al., 2022). Leg blood vessels can be improved by doing diabetic foot exercises regularly. Diabetic foot exercises are done by moving both legs alternately or simultaneously with the aim of helping improve blood circulation so that nutrients reach the tissues more easily and strengthen muscles, lower blood sugar and overcome limited joint mobility (Sardu et al., 2019).

The implementation of diabetes mellitus foot exercises is carried out routinely 4 times a week for 30 minutes, with the aim of increasing carbohydrate metabolism, providing a positive effect on lipid metabolism and contributing to weight loss (Artikaria & Machmudah, 2022). According to research that has been carried out, the movements carried out during diabetic foot exercise interventions are useful for increasing endorphin hormones which help reduce pain, vasodilate blood vessels and cause abnormal blood vessels to widen, resulting in a decrease in blood pressure, especially which is related to brachial systole as indicated by changes in ABI values (Silaban et al., 2019). Patients with diabetes mellitus often experience a decrease in the Ankle Brachial Index (ABI) value, this condition occurs due to clinical symptoms of ischemia, peripheral hypoperfusion which can cause coronary artery disease and diabetic neuropathy (Artikaria & Machmudah, 2022). The intervention in group II was carried out by Neuromuscular Taping (NMT) with the results showing a p value of 0.001, which means there was a difference in the Ankle Brachial Index (ABI) before and after Neuromuscular Taping (NMT). Based on research results, it is proven that giving Neuromuscular Taping (NMT) 6 times in 2 weeks improves the Ankle Brachial Index (ABI). Respondents in intervention group II who were given Neuromuscular Taping (NMT) treatment had higher ABI values after Neuromuscular Taping (NMT), however in control group III the ABI values measured at the same time tended to be the same. The results of this study are in line with previous research with the result that there is a difference in the Ankle Brachial Index (ABI) value after Neuromuscular Taping (NMT) treatment. Neuromuscular Taping (NMT) is a physiotherapy method that uses special elastic bands to help improve the structure of muscles and joints, stimulate neuromuscular activity, and improve blood

circulation. The technique of using adhesive tape which has special characteristics and is elastic to the skin with a decompression or compression method in the area to be treated (Susanti & Arofiati, 2022). This technique is able to provide local therapeutic effects, especially on muscles, blood vessels and lymphatics. The application of Neuromuscular Taping (NMT) can improve the peripheral nervous system so that it can improve the function of neurotransmitters (Kristianto et al., 2020). Neuromuscular Taping (NMT) aims to reduce blockages from body fluids, increase blood vessel circulation, reduce excess heat, improve tissue homeostasis, reduce inflammation and hypersensitivity of pain receptors (Rizal, 2023).

ABI examination is carried out to determine the adequacy of peripheral vascular circulation to the legs in diabetes mellitus sufferers. Poor peripheral circulation in the leg area can trigger ulcers on the feet and will have an impact on complications of diabetic neuropathy. The ABI examination functions to detect clinical signs and symptoms of ischemia, a decrease in peripheral perfusion which can result in diabetic neuropathy. Efforts made to increase the ABI value can be done with diabetic foot exercises and Neuromuscular Taping (NMT). Respondents in the control group did not receive intervention, either NMT or Diabetic Gymnastics, but were given standard care by administering pharmacological therapy in accordance with routine therapy from the Masaran II health center. The results obtained in the ABI value did not change significantly.

CONCLUSION

The results of the analysis carried out on the Ankle Brachial Index (ABI) in the 3 groups showed that, in group I, the diabetic foot exercise intervention 4 times a week, with a duration of 30 minutes, showed that there were changes in results before and after the intervention. Likewise, in group II, the Neuromuscular Taping (NMT) intervention which was carried out for one week with replacement every 3 days showed that there was a change in results before and after the intervention. This research proves that the intervention carried out is a modified management that can be carried out in maintaining the Ankle Brachial Index (ABI) in Diabetes Mellitus patients.

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