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Buerger Allen Exercise and Foot Spa Therapy on Ankle Brachial Index and Foot Sensitivity of Patients with Diabetes Mellitus

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Abstract. Poorly managed diabetes can lead to various complications, including peripheral vascular disease and diabetic neuropathy. Buerger Allen Exercise and foot spa therapy are a series of foot treatments that can overcome DM complications by improving blood circulation characterized by improved ABI values and foot sensitivity. The purpose of this study was to determine the effect of Buerger Allen Exercise and foot spa therapy on Ankle Brachial Index and foot sensitivity of type 2 diabetes mellitus patients in the working area of Antang Health Center, Makassar City. The design of this study was a quasi-experiment without a control group. Samples were taken using purposive sampling on 34 DM patients. Data collection procedures were carried out 15-20 minutes, three times a week for four weeks. The data analysis used was bivariate analysis with Wilcoxon and Mc Nemar tests with a significance level of 0.05. The results showed that the mean value of the right ABI before the intervention of Buerger Allen Exercise and Foot Spa Therapy was 0.94 and after the intervention increased to 1. As for the left ABI, the mean value before and after the intervention was 1. Insensitive feet before the intervention were 35.3% and reduced to 17.6% after being given Buerger Allen Exercise and Foot Spa Therapy. There is an effect of Buerger Allen Exercise and Foot Spa Therapy on ABI values (p-value = 0.016) and foot sensitivity of patients with DM (p-value = 0.031). Buerger Allen Exercise and Foot Spa Therapy need to be socialized to DM patients and families as a support system and still adhere to DM management such as dietary management and others to maximize the results of the intervention.

Keywords: Ankle Brachial Index, Buerger Allen Exercise, Type 2 Diabetes Mellitus, Foot Spa Therapy, Foot Sensitivity

INTRODUCTION

Diabetes mellitus (DM) is a multisystem chronic disease associated with abnormal insulin production, impaired insulin utilization, or both [1]. Type 2 diabetes is the most common type of diabetes and accounts for approximately 90% of all cases of diabetes which is generally characterized by insulin resistance, where the body does not fully respond to insulin. Approximately 422 million people worldwide have diabetes, the majority living in low- and middle-income countries, and 1.6 million deaths are directly attributed to diabetes each year. Both the number of cases and prevalence of diabetes have continued to increase over the past few decades [2]. In Indonesia, the prevalence of diabetes in adults is 6.2% [3]. Based on the results of the Basic Health Research in 2018, South Sulawesi Province experienced an increase in the

prevalence of DM based on doctor's diagnoses in the population aged ≥ 15 years from 2013-2018 [4].

Diabetes that is not managed properly can cause various complications, including peripheral vascular disease and diabetic neuropathy. DM patients are at two to three times the risk of peripheral arterial occlusive disease compared to non-DM patients. Diabetic neuropathy is damage to peripheral nerves that results in sensory disturbances in organs [5]. Peripheral arterial disease is closely related to blood flow circulation, this occurs due to viscosity, one of which is caused by the accumulation of excessive blood sugar levels, which affects blood platelet function and can cause diabetic ulcers and end in amputation [6]. Peripheral circulation disorders can be detected by looking at the Ankle Brachial Index (ABI) value [7].

Interventions that can be taught by health workers, especially nurses, to diabetics who have complications of peripheral perfusion disorders in the lower extremities that are quite widely studied and have a positive effect on improving peripheral perfusion complications in the feet are the Buerger Allen Exercise [8]. Buerger Allen Exercise is a varied lower limb movement exercise and lower limb movements that utilize the force of gravity performed gradually and regularly [9]. Buerger Allen Exercise also has a positive effect on increasing peripheral blood circulation to the extremities thereby increasing the need for oxygen and nutrients necessary for metabolism at the cellular level [10].

Buerger Allen Exercise utilizes the force of gravity to empty blood vessels and increase right atrial flow, which further increases cardiac output [11]. Buerger Allen Exercise effectively improves the circulation of diabetic foot wounds because changes in position and gravitational forces result in contraction of the gastrocnemius musculus as a muscle pump activating venous and arterial blood vessels to open local collateral circulation pathways [12]. Buerger Allen Exercise is very effective in improving peripheral circulation among patients with type 2 diabetes mellitus seen from an increase in ABI values and a decrease in capillary filling time [13-14]. The results of the study showed Buerger Allen Exercise can increase ABI values in patients with type 2 DM [9]. The Buerger Allen Exercise method is effective in improving peripheral perfusion in diabetic feet and can be an easy and inexpensive alternative to improving perfusion disorders, especially in diabetic patients [15].

Buerger Allen Exercise and foot spa therapy are a series of foot treatments that can overcome DM complications by improving blood circulation. Foot spa therapy can increase glutathione metabolism. Glutathione is a cell antioxidant to prevent oxidative damage. Research comparing before and after foot spa therapy found that after treatment there was an increase in the percentage of ABI values by (40%) [16]. Giving foot spa therapy which consists of foot soaking in warm water, foot massage, and foot exercises is very effective in affecting ABI values [17-18]. Improvement in vascularization results in an increase in foot sensation in diabetics [19]. The results of the study showed that foot spa effectively improved foot sensation in diabetics [20].

Based on the results of interviews with 10 patients with type 2 DM in the Antang Health Center Working Area of Makassar City, it can be concluded that DM patients still lack knowledge related to foot care, as well as DM complications such as neuropathy. In addition, regular blood glucose monitoring is not carried out. There are 68 patients with Type 2 DM (T2DM) recorded in the Antang Health Center Working Area. Based on the problems that have been described, the authors are interested in researching the effect of Buerger Allen Exercise and foot spa therapy on Ankle Brachial Index and foot sensitivity of type 2 diabetes mellitus patients in the Antang Health Center working area of Makassar City.

METHODS

This study was conducted using a pretest-posttest without a control group design. The population in this study were all patients with type 2 DM who sought treatment at the Antang Health Center, Makassar City, as many as 68 people, but only 34 people actively participated in PROLANIS exercises. Sampling in this study with purposive sampling and must meet the inclusion criteria, namely PROLANIS participants with Type 2 DM who live in the Antang Health Center Working Area of Makassar City who take medication/insulin injections, willing to become respondents by signing informed consent, patients age> 40 years, suffering from DM> 6 months, DM patients can read and write, and can hear and communicate well. The sample size in this study was 34 respondents.

The research instrument used a questionnaire sheet containing the characteristics of respondents (initials name, age, gender, education level, occupation, income, marital status, length of suffering from DM), observation sheet and ABI procedure, foot sensitivity observation sheet, observation sheet for the implementation of Buerger allen exercise and blood glucose level measurement sheet. Measurement of ABI using a simple hand-held vascular Doppler ultrasound probe and sphygmomanometer. The instrument used to measure foot sensitivity was Siemens Weinstein Monofilament 10.

The data collection procedure was performed for 15-20 minutes, 3x/week for 4 weeks. On the first day of the first week, pretest scores were measured to assess ABI scores and foot sensitivity. Posttest measurements were taken on the last day of week 4 to assess the ABI score and foot sensitivity. Blood glucose was also measured on the first day and the last day to determine the picture of hyperglycemic conditions.

The SPA therapy procedure carried out in this study is to perform a combination of water immersion with a temperature of 38^0C to 40^0C and massage. In the Buerger Allen Exercise procedure, which teaches to change leg positions, DM clients are asked to lie on their backs with their legs raised at 45° to 90° for 1-3 minutes. Then, the client sits on the edge of the bed with the legs hanging. Further exercises include dorsiflexion and plantar flexion, followed by inward and outward movements of the foot. Finally, the client lies supine with the feet covered using a warm blanket for 3-5 minutes [31]. Bivariate analysis on ABI measurements used the Wilcoxon Test because the data distribution was not normal and the Mc Nemar Test on foot sensitivity with the error rate (α) used was 0.05.

RESULTS AND DISCUSSION

3.1 Distribution of Respondent Characteristics

Table 1. Frequency Distribution of Age, Gender, Education Level, Occupation, Marital Status, Genetic History of DM, History of Hypertension, Smoking Habit, DM Medication, and Duration of DM

Age (Mean, SD)	59,38 (6,96)
Gender (n, %)	
Male	6 (17,6)
Female	28 (82,4)
Education Level (n, %)	
Not in School	1 (2,9)
Elementary School	2 (5,9)
Junior High School	7 (20,6)
Senior High School	11 (32,4)
College	13 (38,2)

Occupation (n, %)	
Not Working	10 (29,4)
Government Employee	7 (20,6)
Private Employee	1 (2,9)
Housewife	9 (26,5)
Self-employed	3 (8,8)
Retired	4 (11,8)
Marital Status (n, %)	
Marry	33 (97,1)
Widow	1 (2,9)
Genetic History of DM (n, %)	
Yes	12 (35,3)
No	22 (64,7)
History of Hypertension (n, %)	
Yes	7 (20,6)
No	27 (79,4)
Smoking Habit (n, %)	
Yes	1 (2,9)
No	33 (97,1)
DM Medication (n, %)	
Oral	29 (85,3)
Injection	3 (8,8)
Oral and Injection Combination	2 (5,9)
Duration of DM (Mean, SD)	4,03 (3,24)

Table 1 shows that the average age of DM patients is 59 years where the age interval is in 50-74 years and with a standard deviation of 6.963. There are more women, 82.4%, and the highest education is college, 38.2%, followed by high school education, 32.4%. As many as 97.1% were married and 2.9% were widowed. The most common occupation was not working (29.4%) followed by housewives (26.5%). Most patients (64.7%) had no genetic history of DM, no history of hypertension (79.4%), and no smoking habit (97.1%). Most patients (85.3%) took oral medication. The average blood glucose level during DM patients was 210 with an interval of 73-460 and the average length of DM suffering was 4 years with an interval of 1-15 years.

3.2 Distribution of Respondent Characteristics Distribution of Foot Sensitivity

Table 2. Frequency Distribution of Foot Sensitivity Before and After Given Buerger Allen Exercise and Foot Spa Therapy

Decreased Foot Sensitivity (n, %)	Pretest	Posttest
Yes	12 (35,3%)	6 (17,6%)
No	22 (64,7%)	28 (82,4%)

Table 2 shows that insensitive feet before the intervention were 35.3% and reduced to 17.6% after the intervention.

3.3 Changes in ABI Values

Table 3. Changes in ABI Values Before and After Buerger Allen Exercise and Foot Spa Therapy

	Median (Minimum-Maksimum)	*p-value*
Right ABI before intervention (n=34)	0,94 (0,82-1,17)	0,016
Right ABI after intervention	1 (0,9-1,2)	
Left ABI before intervention	1 (0,77-1,2)	0,003
Left ABI after intervention	1 (1-1,1)	

Table 3 shows the Wilcoxon Test, 7 people experienced a decrease in right ABI values, 4 remained, and 23 increased. On the left ABI, 5 people decreased, 6 remained, and 23 increased. The mean value of the right ABI before being given the Buerger Allen Exercise and Foot Spa Therapy intervention was 0.94 and after being given the intervention increased to 1. As for the left ABI, the mean value before and after being given the intervention was 1. The Wilcoxon test was used because the data was not normally distributed. The test results with $\alpha = 0.05$, showed there was an effect of Buerger Allen Exercise and Foot Spa Therapy on ABI values (p-value = 0.016).

3.4 Changes in Foot Sensitivity

Table 4. Changes in Foot Sensitivity Values Before and After Administration Buerger Allen Exercise and Foot Spa Therapy

Sensitivity Decrease Before Intervention	Decreased Foot Sensitivity After Intervention		Total*p-value*
	Yes	No	
Yes	6	6	12
No	0	22	220,031
Total	6	28	34

Table 4 shows that there is an effect of Buerger Allen Exercise and Foot Spa Therapy on the foot sensitivity of patients with DM (p-value = 0.031). The results of this study show that the average age characteristics of respondents are 59.4 years with a standard deviation of 6.96. The age range of Type 2 DM patients who were used as respondents was 50-74 years, where 15 people (44%) were aged 60 years and over (elderly). Research by Naba et al. (2021) shows that DM patients are more common in the late elderly age group. Gender characteristics show that 82.4% of patients with type 2 DM are female gender. This result is in line with the research of Rahmadani et al. (2022) which shows that most DM patients are female (83.33%). The insulin response in the female body is influenced by the hormone's estrogen and progesterone. Changes in body hormone levels after menopause result in unstable blood sugar levels (Naba et al., 2021).

Educational characteristics show that patients with type 2 DM have the most education up to college (38.2%) followed by high school as much as 32.4%. The level of education can affect the incidence of diabetes mellitus. People with a high level of education will usually have a lot of health knowledge. Through the existence of this knowledge, people will have an awareness of maintaining their health. Conversely, someone with low education has a risk of paying less attention to lifestyle and diet and what to do to prevent DM.

More respondents did not work, namely 29.4% and housewives (26.4%). These results are in line with Susanti's (2019) research which found that most respondents work as housewives. Other studies have revealed that housewives have 2.5 times more work than other jobs. Therefore, housewives are prone to fatigue (Negari, 2020).

The characteristics of marital status showed that 97.1% of patients with type 2 DM were married and 2.9% were widowed. This result is in line with the research of Yanto and Setyawati (2017) which shows that the number of patients with type 2 DM is dominated by patients with married status. Busyness and a high level of stability are closely related to family responsibilities. This can create an unhealthy lifestyle, namely how to choose food and activities that increase the risk of developing various diseases. One of the most common diseases is diabetes mellitus (Arifa et al., 2017).

As many as 64.7% of respondents with a genetic history of DM. The results of Rudi and Kwureh's research (2017) showed a relationship between hereditary history and fasting blood sugar levels in laboratory service users at M. Djoen Sintang Hospital in 2016. Based on research by Mulyani & Kasih (2018) people who have a family history of DM have a 4-fold risk of developing DM compared to people who do not have a family history of DM. This is under the International Diabetes Federation (2021), that several risk factors associated with Type II DM are family history of DM, overweight, unhealthy diet, lack of physical activity, increasing age, hypertension, ethnicity, impaired glucose tolerance (IGT), history of gestational DM, and poor nutrition during pregnancy. The onset of type 2 diabetes mellitus can also be influenced by genetic factors. The risk of a child suffering from type 2 diabetes mellitus is 15% if one of the parents has diabetes mellitus.

The average length of time patients suffer from DM is 4.03 years with an interval of 1-8 years. This follows the research of Meidikayanti and Wahyuni (2017) that the majority of respondents have had DM disease for more than 3 years, namely 27 respondents (54%). A total of 97.1% of patients with type 2 DM do not have a smoking habit. These results are in line with Manao's research (2020), where most of the respondents who suffered from type 2 DM were female, namely 24 people (57.1%), and did not have a smoking habit which caused there was no relationship between smoking and the incidence of type 2 diabetes mellitus in the Medan Deli Health Center working area in 2020. Substances contained in cigarettes cause glucose metabolism disorders. Smoking is a well-known risk factor in many diseases, including type 2 diabetes mellitus. Smoking can increase the risk of developing diabetes in several ways. Smoking has been shown to cause elevated blood glucose concentrations and may increase insulin resistance. Acute smoking can lead to impaired glucose tolerance and decreased insulin sensitivity.

The Ankle Brachial Index (ABI) reflects the arterial hemodynamics of the lower extremities. Decreased ABI values are due to arterial stenosis and indicate peripheral arterial disease (PAD). ABI is recommended for PAD screening and also for the prognosis of risk factors for acute or chronic cardiovascular disease [22].

The results of this study showed that the mean value of the right ABI before the intervention of Buerger Allen Exercise and Foot Spa Therapy was 0.94 and after the intervention, it increased to 1. As for the left ABI, the mean value before and after the intervention was 1. These results are in line with the research of Simarmata et al. which showed that before the intervention it was 0.83 and after the intervention it was 0.95, with a p-value of 0.000, meaning that there was a significant effect between the Buerger Allen exercise and increase in ABI values [24].

The results of the Wilcoxon test in this study with $\alpha = 0.05$, showed that there was an effect of Buerger Allen Exercise and Foot Spa Therapy on ABI values (p-value = 0.016). These results are in line with the research of Hasina et al which shows that there is a significant difference in ABI values before and after the intervention of the Buerger Allen exercise in the intervention group and control group [25]. Likewise, Pebrianti's research showed a difference in the difference in ABI values between the intervention and control groups after being given the Buerger Allen exercise with a value of ($p = 0.00$) [26]. The results of the literature review show that Buerger Allen Exercise (BAE) has proven significant for increasing ABI values and improving peripheral blood flow [27]. The BAE method is effective in improving peripheral perfusion in diabetic feet and can be an easy and inexpensive alternative to improving perfusion disorders, especially in diabetic patients. Buerger Allen Exercise has a good effect on ABI values as an indicator of the effectiveness of peripheral tissue perfusion in people with Diabetes Mellitus [28].

The results of this study also showed that insensitive feet before the intervention were 35.3% and reduced to 17.6% after the intervention. McNemar's test showed there was an effect of Buerger Allen Exercise and Foot Spa Therapy on the sensitivity of the feet of patients with DM (p-value = 0.031). These results are in line with the results of other studies that show there is an effect of Buerger Allen Exercise on foot sensitivity with an average difference before and after Buerger Allen exercise is -2.846 with a p-value of 0.000 (<0.05) so it can be concluded that there is an effect of Buerger Allen exercise on foot sensitivity [29]. Other research results obtained in pairs from the T-test results show significant differences before and after therapy with a value of P = 0.000 (P <0.05). In addition, the Least Significant Difference (LSD) test obtained data on the mean difference of the combination of therapy compared to Bueger's Allen Exercises of 0.0571 (Sig.=0.000) and compared to Foot Spa of 0.0796 (Sig.=0.000). The therapeutic combination method (combination of Foot Spa therapy and Bueger's Allen Exercises) is very effective in improving ABI values in elderly DM [30].

Bueger's Allen Exercises utilize the force of gravity to empty blood vessels and increase right atrial flow, which further increases cardiac output. Gravity plays a role in increasing arteriolar flow. Ankle movements strengthen distal circulation due to the force of muscle contraction. Dorsal-plantar flexion of the foot can also help DM patients use the Achilles tendon to avoid contracture or joint stiffness leading to further foot deformities. Finally, the lying position is supine, which can improve foot reperfusion when the effect of gravity is withdrawn [31]. In addition, Bueger Allen Exercises effectively improve the circulation of diabetic foot wounds because changes in position and gravitational forces result in contraction of the gastrocnemius musculus as a muscle pump activating venous and arterial blood vessels to open local collateral circulation pathways. When someone does Buerger Allen exercise, it will make the leg muscles contract, thus increasing the metabolism in the muscles. This will result in the widening of blood vessels in the foot area, so that blood circulation becomes smooth and the use of glucose in the metabolic process increases and causes foot sensitivity to also increase [32].

Foot Spa Therapy is carried out with skin cleansing, foot massage, and foot exercises, using warm water with a temperature of 39°C to 40°C to relax the blood vessels in the peripheral area so that blood flow in the most distal areas of the body can be fulfilled. Foot movements both gymnastics and walking are effective in increasing foot sensitivity. The stimulation provided in terms of foot movement physiology relaxes and improves blood circulation. Blood circulation allows blood to deliver more oxygen and nutrients to the body's cells, as well as carry more toxins to be removed, so that smooth blood flow will increase the sensation of protection on the skin. During skin cleansing activities, the feet are soaked using warm water mixed with salt. Warm water and salt are beneficial for improving blood circulation, because warm water can create vasodilation in blood vessels [16].

Foot Spa therapy uses immersion using warm water which stimulates blood circulation to be smoother. Foot massage increases endorphin secretion which is effective in vasodilating blood vessels. Blood circulation in the blood vessels is stimulated and there is a pressure difference in facilitating blood flow due to muscle contraction. Physical activity can improve foot sensitivity such as diabetes mellitus foot exercises because it can improve blood flow, strengthen small muscles, prevent foot deformities, overcome joint motion limitations, and improve the fitness of diabetes mellitus clients. Therefore, doing Buerger Allen exercise can help to improve foot sensitivity in people with diabetes mellitus. Physical activity can increase the use of glucose by active muscles to reduce blood glucose levels. Physical activity involves various stretching movements in all directions besides that it can also increase blood flow to the lower extremities so that it can prevent peripheral arterial disease in people with diabetes mellitus. Physical activity can also increase the sensitivity of insulin receptors in active muscles, thereby increasing glucose utilization in cells. The results of the study showed that the results of blood sugar levels and foot sensitivity were much better after being given foot exercises. Combination therapy is a non-pharmacological treatment to improve ABI values and foot sensitivity in patients with type 2 DM in particular to reduce the risk of neuropathy and can prevent complications due to diabetic ulcers or amputation [33].

CONCLUSIONS

The middle value of the right ABI before and after the intervention of Buerger Allen Exercise and Foot Spa Therapy has increased, but the left ABI value is fixed. However, both were still within the normal range. As for the non-sensitive foot before and after the intervention, there was an improvement. Buerger Allen Exercise and Foot Spa Therapy need to be socialized to DM patients and their families as a support system. DM management such as dietary management and others are still adhered to maximize the results of the intervention.

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