COMPREHENSIVE HEALTH CARE e-ISSN : 2722-1563 p-ISSN : 2580-7137

The Effect of Foot Soak Therapy on Ankle Brachial Index (ABI) Values in Type 2 Diabetes Mellitus Patients

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Article Info
Article History:
Received : 16 March 2023
Revised : 31 May 2023
Accepted: 19 December 2024

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DOI

https://doi.org/10.37362/chc.v8i3.46

P- ISSN : 2722-1563
E -ISSN : 2580-7137

ABSTRACT

Diabetes mellitus has become a chronic disease with the number of patients increasing every year globally. Ironically, type two diabetes mellitus increases the risk of vascular complications including lower extremities that cause diabetic ulcers and amputation. Peripheral circulation disorders can be detected by looking at ABI values. Warm water soak on the feet is one way of foot care that can be done to improve circulation prefer blood flow. The heat reaction will increase circulation, improve nutrient delivery, removal of residual substances and reduce mild congestion within the injured tissue in the area, thus improving tissue anoxia caused by pressure and thickening of blood vessels. The purpose of this study was to determine the effect of warm water foot bath therapy on ABI values in patients with Type 2 Diabetes Mellitus. This study uses a quantitative approach that uses a Quasi experimental design of one group pre and post-test. The location and time of the research will be carried out in the work area of the Binanga Health Center, Mamuju Regency in 2024. the sample size was 50 respondents with simple random sampling technique. The results of the analysis showed that the average ABI value before the Warm Water Foot Soak intervention was 0.85 while the average ABI after the Warm Water Foot Soak intervention was 0.89. The statistical results of the paired t-test test for the value of P = 0.000 (P <0.05) So it can be concluded that there is a significant difference between the ABI values before and after being given the Warm Water Foot Soak treatment which indicates a positive change in ABI improvement. As for the suggestions of this study
Warm Water Foot Soak Therapy can be used as one of the nursing interventions in Type II Diabetes Melitus patients as a preventive measure for peripheral blood circulation disorders.

Keywords: Ankle Brachial Index; Type 2 Diabetes Mellitus; Warm Water Foot Soak

INTRODUCTION

Diabetes mellitus is a chronic disease whose prevalence continues to increase globally (1), including in Indonesia, which currently ranks 7th in the world as the country with the highest number of diabetics (2). This disease is not only characterized by elevated blood glucose levels, but is also accompanied by various complications, both

microangiopathy and macroangiopathy. One of the common macroangiopathic complications in diabetic patients is peripheral arterial disease (PAD), which can be measured through the Ankle Brachial Index. A low Ankle Brachial Index value indicates impaired blood flow to the lower extremities, potentially leading to diabetic ulcers and increasing the risk of amputation in patients with diabetes mellitus (3).

Ankle Brachial Index is a non-invasive parameter used to detect blood circulation disorders in the lower extremities. In patients with diabetes mellitus, the risk of Ankle Brachial Index impairment increases with disease duration, poor blood sugar control, and unhealthy lifestyles, such as physical inactivity. Therefore, effective prevention and management strategies for Ankle Brachial Index impairment are necessary to prevent more serious complications (4).

One intervention that has begun to be researched is warm water foot bath therapy. In addition to reducing pain as described in a study conducted by Haksara (5), this therapy is also believed to improve blood circulation in the lower extremities through a vasodilating effect, potentially improving ABI values in patients at risk of peripheral arterial disease (6). Several previous studies have shown that this therapy is effective in improving blood circulation and improving symptoms associated with PAD, but more specific research related to the effectiveness of foot bath therapy on Ankle Brachial Index values in patients with type 2 diabetes mellitus is still limited, especially in Indonesia (7).

Based on this background, this study aims to evaluate the effect of warm water foot bath therapy on Ankle Brachial Index values in patients with type 2 diabetes mellitus in the Binanga Health Center working area, Mamuju. This study is expected to make a significant contribution to the prevention and management of vascular complications in diabetic patients, as well as a reference for health services at puskesmas and other health facilities in implementing simple but effective non-pharmacological interventions.

MATERIAL AND METHOD

This study uses a quantitative approach that uses a Quasi experimental design of one group pre and post-test. The location and time of the research will be carried out in the Binanga Health Center work area, Mamuju Regency from August - September 2024. The sampling technique uses the Slovin formula, based on the total population that has been recorded in the Binanga Health Center medical record in the last month, namely 98

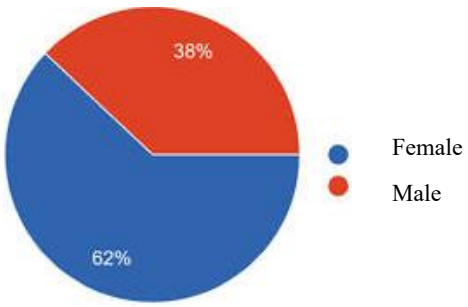
patients with diabetes mellitus and a sample size of 50 respondents has been determined by the random method. The method of data collection is carried out from home to home in coordination with the Puskesmas or local Health Facility, then notification and scheduling of visits, implementation of home visits by explaining the purpose and benefits of the study, then conducting an Ankle Brachial Index examination if the Ankle Brachial Index value is below 0.91 will be determined as a prospective respondent by giving consent to prospective respondents and then given intervention until the evaluation of the Ankle Brachial Index value.

RESULTS

The results of this study describe the univariate and bivariate analysis. Univariate analysis describes the characteristics of respondents such as gender, age, history of hypertension, smoking history and duration of Diabetes Mellitus. While bivariate analysis compares Ankle Brachial Index values before and after intervention and sees the significance of the T test.

Respondent Characteristics Gender

Figure 1. Respondent Gender Data



Source: Primary Data, 2024

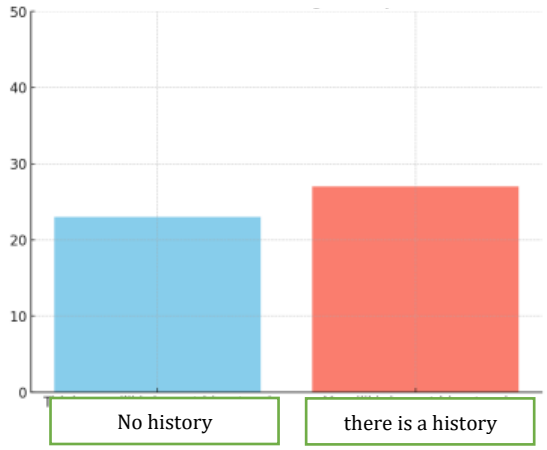
The diagram displays the percentage distribution of gender where out of a total of 50 respondents studied, 19 respondents or 38.0% were male, while 31 respondents or 62.0% were female.

Table 1. Respondent Age Data

Characteristics	Mean	Median	Mode	Min	Max
Age	53,38	57	48 & 59	38	68

The data above shows that the average age of diabetic patients in the Binanga Health Center is about 53.38 years old. Half of the patients were 57 years old or less, and half were 57 years old or more. The most common ages found in patients were 48 and 59 years old, and the age range of patients varied from 38 years old to 68 years old.

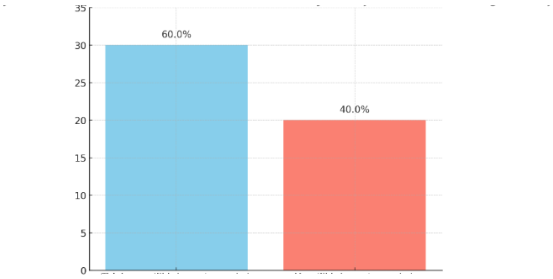
Figure 2. Respondents' Hypertension History Data



The graph shows the distribution of hypertension history in 50 respondents with diabetes mellitus in the Binanga Mamuju Health Center working area. Of the total 50 respondents, 23 respondents (46.0%) did not have a history of hypertension and 27 respondents (54.0%) had a history of hypertension. The proportion of respondents who had a history of hypertension was higher (54%) than those who did not (46%).

Smoking History

Figure 3. Respondents' Smoking History Data



The graph above shows data on smoking history in diabetes mellitus patients in the Binanga Health Center working area, Mamuju. Of the total 50 respondents, 60% (30 respondents) did not have a history of smoking, while 40% (20 respondents) had a history of smoking.

Duration of Diabetes Mellitus

Table. 2 Data on Respondents' Length of DM Suffering

Characteristics	Mean	Median	Mode	Min	Max
Duration of DM	9.4400	8.0000	6.00	3.00	15.00

Source: Primary Data, 2024

The data above shows that the average diabetic patient in the Binanga Mamuju Health Center working area has suffered from this disease for about 9.4 years. However, the range of time suffering from diabetes is quite varied, ranging from 3 years to 15 years. This indicates that there

are patients who have just been diagnosed with diabetes and there are also patients who have suffered from diabetes for a long time.

Table 3. Ankle Brachial Index value data before and after intervention

Warm Water Foot Soak	Ankle Brachial Index Measurement		*P Value*
	Mean	SD	
Before (50)	0. 85	4.450	0.001
After (50)	0.89	4.855	

The results of the analysis showed the average value of the Ankle Brachial Index before the Warm Water Foot Soak intervention was 0.85 while the average Ankle Brachial Index after the Warm Water Foot Soak intervention was 0.89. The statistical results of the paired t-test for the value of P = 0.000 (P <0.05) which indicates a positive effect on increasing the value of the Ankle Brachial Index after being given a warm water foot bath intervention.

DISCUSSION

Respondent Characteristics Gender

The percentage distribution of gender where out of a total of 50 respondents studied, 19 respondents or 38.0% were male, while 31 respondents or 62.0% were female.

This finding is in line with several previous studies conducted by Ciarambino et al (2022) with the title Influence of Gender in Diabetes Mellitus and Its Complication which shows the prevalence of diabetes mellitus in women tends to be higher than men (8). The research conducted by renovaldi explained that gender differences, most of the respondents were female, namely 47 people (78.3%) and 12 of the 47 female respondents had abnormal ABI examination results (9). Factors that may contribute are hormonal changes in women, especially after menopause, can increase the risk of insulin resistance and diabetes mellitus which, if not properly controlled, will cause changes in the Ankle Brachial Index value (10).

Age

The data showed that the average age of diabetic patients in the Binanga Health Center was about 53.38 years old. Half of the patients were 57 years old or less, and half were 57 years old or more. The most common ages found in patients were 48 and 59 years old, and the age range of patients varied from 38 years old to 68 years old.

It can be concluded that the average age of diabetes mellitus patients in the Binanga Mamuju Health Center working area is around 53.38 years, with a fairly wide age range,

from 38 to 68 years. This finding indicates that diabetes mellitus with impaired peripheral vascularization of the Ankle Brachial Index is more common in the middle to advanced age group. This is in line with research conducted by Awalin et al (2020) which explains that there is a relationship between age and poor ankle brachial index values (11). Age is closely related to the increase in blood glucose levels, so that the increasing age, the prevalence of diabetes and impaired tolerance to glucose is getting higher which also has an impact on complications of Diabetes Mellitus including lower extremity blood circulation disorders (12).

According to the AHA (2020) old age is the main risk factor for a person suffering from PAP (a condition of narrowing of the arteries that causes blood flow to be disrupted especially towards the lower limbs (13). The risk of PAP increases with age, from 3% in patients <60 years old to 20% in patients >75 years old and is also found in patients ≤50 years old, but the number of cases is very small. The relationship between age and PAP reflects the longer duration of exposure to atherogenic factors and the cumulative effects of aging on blood vessels. The aging process naturally causes blood vessels in old age to be more susceptible to atherosclerosis, causing disturbances in peripheral circulation characterized by a decrease in the Ankle Brachial Index value (14).

History of Hypertension

Distribution of hypertension history in 50 respondents with diabetes mellitus in the Binanga Mamuju Health Center working area. Of the total 50 respondents, 23 respondents (46.0%) did not have a history of hypertension and 27 respondents (54.0%) had a history of hypertension. The proportion of respondents who had a history of hypertension was higher (54%) than those who did not (46%).

This suggests that more than half of diabetes mellitus patients in this region also have hypertension. This can be an additional risk factor in diabetes management. This condition needs to be considered in health interventions, given the relationship between hypertension and diabetes complications that can aggravate the patient's condition.

The results of this study are in line with Jelantik's (2014) research on 50 respondents with Type II Diabetes Mellitus patients found that 88% of respondents suffered from hypertension and 12% of respondents did not suffer from hypertension (15). This can also affect the results of the average increase in the value of the Ankle

Brachial Index because a history of hypertension has an influence on the decrease in the value of the Ankle Brachial Index and indicates a peripheral vascularization disorder (16). In this study, the length of time the respondent suffered from hypertension was not examined, only whether the respondent had a history of hypertension or not.

Hypertension can also influence the incidence of peripheral arterial disease through its role in the process of arteriosclerosis. Hypertension can cause arteriosclerosis by various mechanisms, including endothelial dysfunction that causes remodeling of the arterial wall and decreased lumen diameter. Abnormalization of homeostasis factors that cause the renin angiotensin aldosterone system to produce ACE and increase Angiotensin-II, causing increased blood volume, and vasoconstriction. Cardiac output and peripheral resistance are not balanced so that there is an increase in ventricular mass and smooth muscle cell proliferation, then the blood vessels will be thickened and inelastic. The results of the various mechanisms above are some of the causes of atherosclerosis. High blood pressure can also cause arteries to dilate and overstretch, resulting in endothelial injury. Endothelial dysfunction causes abnormal vascular smooth muscle tone, vascular smooth muscle cell proliferation, impaired coagulation and fibrinolysis and persistent inflammation (17).

Smoking History

The graph shows data on smoking history in patients with diabetes mellitus in the Binanga Health Center working area, Mamuju. Of the total 50 respondents, 60% (30 respondents) did not have a history of smoking, while 40% (20 respondents) had a history of smoking.

About 40% of the respondents had a history of smoking. This shows that smoking is still quite high among diabetics in the binanga mamuju Healt Center working area.

This is in line with research conducted by Wang et al which explains that there is a relationship between smoking history and a decrease in the Ankle Brachial Index value in people with diabetes (18). Smoking history is one of the main risk factors for cardiovascular disease, including peripheral arterial disease (PAD). PAD is characterized by narrowing or blockage of arteries, especially in the legs, and one of the parameters to diagnose PAD is the Ankle Brachial Index. Peripheral arterial disease usually blocks medium to large arteries and attacks the lower limbs, increasing the incidence of

gangrene in the feet of Diabetes Mellitus patients. Free radicals in cigarettes will trigger a decrease in endothelial function. As a result of this decrease in function, inflammatory cells, platelets, and LDL will easily adhere to the blood vessel wall so that it can form plaques in blood vessels and cause atherosclerosis. If exposure to free radicals occurs continuously, it will cause blood vessel damage and circulation disorders (19).

Duration of Diabetes Mellitus

Data shows that the average diabetic patient in the Binanga Mamuju Health Center working area has suffered from this disease for about 9.4 years. However, the time span of suffering from diabetes is quite varied, ranging from 3 years to 15 years. This indicates that there are patients who have just been diagnosed with diabetes and there are also patients who have suffered from diabetes for a long time.

This study is in line with research conducted by Cahyono et al (2019) which explains that there is a long relationship with Diabetes Mellitus with the Ankle Brachial Index value (20). The length of time a person experiences Diabetes Mellitus can increase the risk of complications of Diabetes Mellitus, one of which is the inhibition of peripheral vascularization so that it can reduce the value of the Ankle Brachial Index, and result in ulcers (21). Long increases in blood sugar levels result in damage to the lumen of the blood vessels. Damage to the blood vessel lumen will affect peripheral circulation. Hyperglycemia for a long time will cause a buildup of glucose levels in certain cells and tissues which are then converted into sorbitol which is the cause of damage and changes in cell function. Sorbitol metabolizes slowly, then added to the formation of Advanced Glycation End Products (AGEs). AGEs are substances that cannot be metabolized further so that they accumulate in the blood vessel wall and cause atherosclerosis which causes vascular disorders so that peripheral circulation is impaired (22).

Difference in Ankle Brachial Index values before and after Warm Water Foot Soak intervention

The results of the analysis showed the average value of the Ankle Brachial Index before the Warm Water Foot Soak intervention was 0.85 while the average Ankle Brachial Index after the Warm Water Foot Soak intervention was 0.89. The statistical results of the paired t-test for the value of $P = 0.000$ ($P < 0.05$) which indicates a positive effect on

increasing the value of the Ankle Brachial Index after being given a warm water foot bath intervention.

By soaking the feet using warm water 380C for 5 minutes with the aim of softening dead skin cells or dirt contained in skin cells that are difficult to reach with a brush or cleaning tool. In addition, this action will soften dry feet so that it is easier to think about dead skin cells. Soaking the feet with warm water and mixed with salt while serving to soften the skin cleaning the skin can also reduce swelling in the feet. Salt, which is rich in sodium content, can bind water to intra-cells and intercells out due to differences in concentration so that swelling and inflammation can be reduced (23). Soaking the feet with warm water As is known that the function of warm water is useful for improving blood circulation because warm water can make vasodilation in blood vessels. Water is the right therapeutic medium for injury recovery, because scientifically warm water has a physiological impact on the body. First, it has an impact on blood vessels, namely making blood circulation smooth. Secondly, the loading factor in the water will strengthen the muscles and ligaments that affect the joints of the body (24). In addition, the warm temperature of the water will increase tissue flexibility. Water is utilized as a trigger to improve strength levels and disease resistance. Water therapy is a good way to increase endurance, improve blood circulation and trigger the elimination of toxins (25).

CONCLUSION

Characteristics of respondents based on gender of 50 respondents with diabetes mellitus in the Binanga Mamuju Health Center work area, 38% were male and 62% were female, it can be concluded that the prevalence of diabetes mellitus in women in the area is higher than men. As for age characteristics, the average age of patients with diabetes mellitus in the Binanga Mamuju Health Center working area is around 53.38 years, with a fairly wide age range, from 38 to 68 years. Then respondents who had a history of hypertension were also higher than those who did not have a history of hypertension, namely 23 respondents (46.0%) did not have a history of hypertension and 27 respondents (54.0%) had a history of hypertension. Furthermore, smoking history is about 40% of respondents who have a history of smoking and 60% of respondents who do not have a history of smoking. This shows that smoking habits are still quite high among diabetics in the binanga mamuju health center work area. And characteristics

according to the length of time suffering from Diabetes Mellitus averaged around 9.4 years. However, the range of time suffering from diabetes is quite varied, ranging from 3 years to 15 years.

The average Ankle Brachial Index value before the Warm Water Foot Soak intervention was 0.85 while the average Ankle Brachial Index after the Warm Water Foot Soak intervention was 0.89. The statistical results of the paired t-test for the value of $P = 0.000$ ($P < 0.05$) which indicates a positive effect of increasing the value of the Ankle Brachial Index after the intervention.

Warm Water Foot Soak Therapy can be used as one of the nursing interventions in Type II Diabetes Melitsus patients as a preventive measure for peripheral blood circulation disorders of the feet. However, to carry out these interventions, implementing nurses must be able to carry them out correctly so that improvement and skills are needed in implementing these interventions. In addition, the intervention of warm water foot soak therapy can be used as a Standard Operating Procedure in nursing care for the prevention of peripheral arterial disease that attacks many lower limbs.

ACKNOWLEDGMENTS

With all humility, I would like to express my deep gratitude to those who have provided support, assistance, and contributions during the implementation of this research: 1) The Ministry of Education, Culture, Research and Technology, which has provided significant financial assistance and moral support. This assistance became an important foundation for the continuity and success of the research we carried out. The support from the Ministry not only facilitates us materially, but also encourages us to contribute more to the academic and research world. 2) ST. Fatimah Mamuju, which through its various sections and institutions such as LPPM, provides full support for this research. Thank you for the opportunity and facilitation provided, so that we can carry out the research well. 3) Binanga Community Health Center, which has made an outstanding contribution to the research data collection process. Thank you for the close cooperation, time, and dedication of the health workers in assisting us during field data collection. This assistance has contributed significantly to the success of the research conducted.

AUTHOR CONTRIBUTIONS

IB and RMD designed and developed the experiments; IB and RMD performed the experiments; IRM was responsible for data analysis; SYH, IB, and RMD contributed to the provision of reagents, materials, and analytical tools; and all authors contributed to the writing of the manuscript. All authors have read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest related to the conduct of this research, interpretation of the results, or in the writing and publication of this article. All research activities were conducted independently and objectively, without any influence from third parties that could affect the results of the study.

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