

Effect of Ankle Range of Motion Exercises Combined with Warm Water Foot Soaking on Ankle–Brachial Index in Patients with Type 2 Diabetes Mellitus

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ABSTRACT

Introduction: Diabetes mellitus has attracted global attention due to the increasing prevalence of cases and the potential complications it can cause, such as microangiopathy and macroangiopathy. One non-pharmacological intervention that can be applied to improve peripheral circulation is the combination of ankle range of motion (ROM) exercises and warm water foot soaking.

Objective: This study aimed to determine the effect of the combined ankle ROM exercises and warm water foot soaking on Ankle Brachial Index (ABI) values in patients with Type 2 Diabetes Mellitus at Kedaton Public Health Center, Bandar Lampung, in 2025.

Method: This study employed a quantitative approach with a pre-experimental design using a one-group pretest and posttest without control. A total of 30 respondents were selected using purposive sampling techniques. Data analysis included descriptive statistical analysis, a normality test using Shapiro Wilk, and a non-parametric test using the Wilcoxon Signed Rank Test.

Result The results showed that the mean ABI value before the intervention was 0.0093 ± 0.04265 , while after the intervention the mean ABI value improved to 0.0012 ± 0.03038 . The Wilcoxon test revealed a p-value of 0.025, indicating a statistically significant difference between ABI values before and after the intervention.

Conclusion: It can be concluded that the combination of ankle range of motion (ROM) exercises and warm water foot soaking has a significant effect on improving ABI values in patients with Type 2 Diabetes Mellitus, and therefore can be applied as a non-pharmacological nursing intervention to enhance peripheral blood circulation.

Keywords: ankle brachial index (ABI), ankle rom, type 2 diabetes mellitus, warm water foot

Introduction

Diabetes Mellitus (DM) is a serious and chronic disease characterized by persistently high blood glucose levels due to insufficient insulin production or the body's inability to use the insulin it produces. Diabetes affects people of all ages, genders, and regions, making it one of the most common causes of death and a global health problem. Globally, the number of chronic diabetes sufferers is increasing, with Indonesia ranking fourth among the ten countries with the highest diabetes prevalence worldwide, making this health problem a global crisis (Hossain et al., 2024).

According to data from the World Health Organization (WHO), in 2022, 14% of adults aged 18 and over had diabetes, up from 7% in 1990. More than half (59%) of adults aged 30 and over with diabetes were not taking their diabetes medication in 2022. Diabetes treatment coverage was lowest in low- and middle-income countries. Diabetes was the direct cause of 1.6 million deaths in 2021, with 47% of diabetes deaths occurring before the age of 70. An estimated 530,000 deaths from kidney disease were attributed to diabetes, and high blood sugar levels contributed to approximately 11% of deaths from cardiovascular disease (WHO, 2024).

According to data from the International Diabetes Federation (IDF), in 2021, 536.6 million people had diabetes (both diagnosed and undiagnosed), and this figure is expected to increase by 46%, reaching 783.2 million by 2045 (IDF, 2021). Consistent with previous IDF estimates and other studies, approximately 50% of people with diabetes are unaware that they have the condition (Ogurtsova et al., 2022).

Based on the 2023 Indonesian Health Survey (SKI), the prevalence of diabetes mellitus (DM) based on blood sugar levels in residents aged 15 years and older was 11.7%. (Perkeni, 2021). The Lampung Provincial Health Office stated that in 2024, the total number of diabetes mellitus (DM) cases in the province reached 96,583. Bandar Lampung City topped the list with the highest number of DM patients, with a total of 18,644 cases, which continued to increase to 20,437 cases in 2024. This was followed by Central Lampung with 14,252 cases, and East Lampung with 13,340 cases (Lampung Provincial Health Office, 2024).

The Kedaton Community Health Center in Bandar Lampung City is one of the inpatient community health centers with 11,438 visits per year. Diabetes mellitus cases at the Kedaton Community Health Center ranked fourth among the ten most common diseases. However, the number of diabetes mellitus cases at the Kedaton Community Health Center has increased significantly. In 2022, the number of diabetes mellitus cases at the Kedaton Community Health Center was 934 cases, increasing to 1,095 cases in 2023 and 1,678 cases in 2024. In 2025, from January to August, the number of diabetes mellitus cases reached 748 cases (Kedaton Community Health Center, 2025).

Diabetes mellitus can cause complications such as hypoglycemic coma, hyperglycemic ketoacidosis, or non-ketoacidosis. Furthermore, if left untreated, diabetes mellitus can lead to various long-term complications, such as microangiopathy and macroangiopathy, leading to cerebrovascular disease, coronary heart disease, leg vascular disease, complications in the eyes, kidneys, and nerves, and an increased risk of infection (Hendro Djoko Tjahjono, 2019).

One complication frequently experienced by people with diabetes mellitus is peripheral neuropathy, with symptoms such as burning sensations in the feet, tingling/numbness, and increased pain. Peripheral neuropathy is a major factor in the development of diabetic ulcers, a common complication in people with diabetes mellitus. Diabetic foot ulcers occur in more than 2% of patients annually, affecting 5–7.5% of patients with neuropathy. Several studies have shown that peripheral neuropathy can increase the likelihood of developing diabetic

ulcers. Peripheral neuropathy results in impaired motor, sensory, and autonomic function. Motor impairments result in muscle atrophy, leg deformities, and biomechanical changes, as well as weight-bearing changes. Autonomic impairments result in decreased sweat excretion in the feet, leading to dry skin that is prone to cracking. Sensory impairments cause loss of sensation or numbness in distal areas, and more than 50% of peripheral neuropathy cases may be asymptomatic (Sriyati, 2024).

Comprehensive management is necessary to prevent complications of diabetes mellitus. Efforts to prevent complications include nutritional therapy, medication/pharmacology, self-monitoring of blood sugar, and activity/exercise. Activities/exercise include aerobics, muscle strength training, and flexibility exercises involving the upper and lower body, including ankle range of motion (ROM) exercises, which improve blood circulation, maintain muscle strength, and reduce pain. In addition to ROM exercises, ankle foot soaks can also be performed, which improve blood circulation, relieve numbness, and aid muscle relaxation.

Ankle Range of Motion (ROM) exercises are performed to maintain joint flexibility, blood circulation, and maintain or improve the ability to move joints normally in the ankle. Early ankle range of motion exercises can increase muscle strength by stimulating motor units. The more motor units involved, the greater the muscle strength. However, if left untreated, hemiparesis can lead to permanent disability (Anggriani et al., 2018). In addition to ankle range of motion exercises, soaking feet in warm water is a beneficial foot therapy that improves blood flow through vasodilation, the widening of blood vessels. The optimal temperature of 37-40°C accelerates blood circulation and can also reduce foot pain in patients with diabetes mellitus (Deski & Yendrial, 2025).

Based on data from a pre-survey at the Kedaton Community Health Center on October 10, 2025, the number of diabetes mellitus cases in 2022 reached 934. This number increased to 1,095 in 2023, and reached 1,678 in 2024. Diabetes mellitus at the Kedaton Community Health Center fluctuated throughout 2025, with 152 cases in April, 168 in May, 118 in June, 150 in July, and 156 in August. Interviews with Community Health Center staff revealed that the Community Health Center's efforts to manage Type 2 Diabetes Mellitus cases include implementing the Prolanis program, which routinely includes scheduled Prolanis exercises, blood sugar checks during community health post (Posbindu), and diabetic foot care visits (if needed).

Previous research on ankle range of motion (ROM) exercises has been extensively conducted. However, research combining ankle ROM exercises with warm water foot soaks on the ankle-brachial index in patients with diabetes mellitus is still limited. Therefore, based on the phenomenon in the field and the limited research that has been conducted, the researcher is interested in conducting a study entitled "The Combination of Ankle ROM Exercises and Warm Water Foot Soaks on the Ankle-Brachial Index in Type 2 Diabetes Mellitus Patients in the Work Area of the Kedaton Inpatient Community Health Center, Bandar Lampung in 2025."

Objective

This study aimed to determine the effect of the combined ankle ROM exercises and warm water foot soaking on Ankle Brachial Index (ABI) values in patients with Type 2 Diabetes Mellitus at Kedaton Public Health Center, Bandar Lampung, in 2025.

Method

The type of research used in this study is quantitative, namely the type of research that produces new findings that can be achieved (obtained) by using statistical procedures or other means of quantification (measurement) (Jaya, 2020). The design that will be used in this study is pre-experimental, which is carried out by conducting one measurement in advance (pre-test) before the treatment (treatment) and after that another measurement (post-test) is carried out with a one group pretest and posttest approach without control design (Ibrahim et al., 2018). This study aims to determine the effect of the combination of Ankle Range Of Motion (ROM) and Warm Water Foot Soak on ABI values in a group of adults with Type 2 Diabetes Mellitus at the Kedaton Health Center, Bandar Lampung in 2025. This study employed a quantitative approach with a pre-experimental design using a one-group pretest–posttest without control. A total of 30 respondents were selected using purposive sampling techniques. Data analysis included descriptive statistical analysis, a normality test using Shapiro Wilk, and a non-parametric test using the Wilcoxon Signed Rank Test.

Result

Table 1. Frequency Distribution of Respondent Characteristics of Type 2 Diabetes Mellitus Sufferers

Respondent Characteristics	Frequency (n)	(%)
Gender		
Male	5	16.7
Female	25	83.3
Age		
30-40 Years	8	26.7
41-59 Years	22	73.3
duration of suffering from DM		
1-3 Years	11	36.7
4-5 Years	19	63.3
Total	30	100

Based on table above it can be seen that in the gender category, the largest number are women, namely 25 respondents (83.3%), in the age category the largest number are in the 41-59 year age range, as many as 22 respondents (73.3%), while in the category of duration of suffering from DM, the majority have suffered from DM for 4-5 years, amounting to 19 respondents (63.3%).

Table 2. Ankle-Brachial Index (ABI) Values Before the Combination of Ankle ROM Exercises and Warm Foot Soaks in Type 2 Diabetes Patients

Group	Frequency (n)	(%)
Nilai Ankle Brachial Index		
>1,0 Normal	19	63.3
< 0,9 LEAD	9	30.0
< 0,6-0,8Boderline	2	6.7
Total	30	100

Based on Table above the Ankle-Brachial Index (ABI) values before the combination of Ankle ROM Exercises and Warm Foot Soaks were administered to 30 respondents with Type 2 Diabetes. Most respondents had ABI values in the normal category (>1.0), namely 19 (63.3%). Furthermore, there were 9 respondents (30.0%) in the <0.9 (LEAD) category, while there were 2 respondents (6.7%) in the <0.9 (Borderline) category.

Table 3. Ankle-Brachial Index (ABI) Values after the Combination of Ankle ROM Exercises and Warm Foot Soaks in Type 2 Diabetes Patients

Group	Frequency (n)	(%)
Nilai Ankle Brachial Index		
$>1,0$ Normal	26	86.7
$< 0,9$ LEAD	4	13.3
Total	30	100

Based on Table 4.3, the Ankle Brachial Index (ABI) values after a combination of ROM exercises and warm foot soaks in patients with type 2 diabetes mellitus (DM), the results show that of the 30 respondents, the majority had ABI values in the normal category (>1.0), namely 26 (86.7%). Meanwhile, 4 (13.3%) respondents remained in the <0.9 (LEAD) category.

Table 4. The Effect of a Combination of Ankle ROM Exercises and Warm Water Foot Soaks on Type 2 Diabetes Patients

Group	Frequency (n)	<i>p-value</i>
Nilai Ankle Brachial Index (ABI) Pretest	30	0,025
Nilai Ankle Brachial Index (ABI) Posttest		

Based on table above, it is known that there is a significant difference in the Ankle Brachial Index (ABI) value before and after applying the combination of Ankle ROM exercises and soaking feet in warm water with a *p-value* of 0.025 (*p-value* <0.05).

Discussion

Based on the Wilcoxon Signed Rank Test, the Ankle Brachial Index (ABI) *p-value* was <0.025 , indicating that H_a was accepted and H_o was rejected. This indicates a combined effect of ankle ROM exercises and warm water foot soaks on the Ankle Brachial Index (ABI) in patients with type 2 diabetes mellitus at the Kedaton Community Health Center in 2025.

Ramayanti et al., 2024, states that active lower extremity ROM is a form of exercise involving joint movement that utilizes the lower extremities. During active lower extremity ROM exercises, the leg muscles contract continuously, compressing the blood vessels, activating the venous pump to pump blood to the heart, thus improving arterial blood circulation, which carries nutrients and oxygen to the peripheral blood vessels. Furthermore, Maryama et al., 2021, reported that soaking feet in warm water has a positive effect on blood vessels and stimulates the nerves in the soles of the feet. The nerves in the feet lead to vital organs, including the heart, lungs, stomach, and pancreas. This promotes increased tissue perfusion in the lower extremities, optimally regulating ankle blood pressure and contributing

to an increased ABI. Therefore, people with type 2 diabetes mellitus are recommended to engage in regular physical activity, including structured, moderate-intensity exercise for at least 150 minutes per week, or approximately 10 minutes per session, 2–3 days per week, to help improve peripheral circulation and prevent vascular complications (Harrington, 2021).

Previous research by Basri et al., 2024, showed that lower joint range-of-motion (ROM) exercises can improve blood circulation and strengthen the small muscles of the feet, prevent foot deformities, and address insulin limitations in people with diabetes mellitus, which cause elevated blood sugar levels and damage to blood vessels, nerves, and structures. Furthermore, according to research conducted by (Yuliantini et al., 2023), active lower range of motion (ROM) exercises can increase muscle strength and tendon reflexes, improve protective sensation and ABI values, and minimize diabetic polyneuropathy symptoms, thereby preventing complications of foot ulcers. Furthermore, research conducted by (Mardhalena & Kurnia, 2025) explains that warm water immersion has the benefit of increasing blood flow to an area and can also reduce pain by accelerating healing.

This significant change in ABI values can be interpreted as increased blood vessel elasticity and improved blood flow in the lower extremities. ABI is an important indicator for assessing the risk of peripheral arterial disease (PAD), which is common in people with type 2 diabetes mellitus. Increased blood flow and improved vascular function after the combined exercise regimen indicate that this intervention is effective in reducing the risk of PAD and improving vascular health (ADA, 2021).

The findings of this study have highly strategic clinical implications for improving ABI values. The increase in the Ankle Brachial Index (ABI) value after the intervention indicates that the combination of ankle ROM exercises and warm water foot baths is an effective therapeutic modality to optimize vascular status in patients with type 2 diabetes mellitus. The physiological mechanism of warm water foot baths that provide vasodilatory effects, when combined with ankle ROM exercises that trigger muscle contractions, can stimulate peripheral blood flow more optimally compared to single interventions. Therefore, this combination of interventions is highly recommended to be integrated into a comprehensive diabetes management program. Exercises performed consistently and structured can be a significant preventive step in minimizing the risk of complications of peripheral artery disease (PAD) which often reduce the quality of life of patients with diabetes. The combination of these two methods provides long-term benefits in maintaining the stability of tissue perfusion in the lower extremities.

Conclusion

Ankle-Brachial Index (ABI) values after a combination of ankle ROM exercises and warm foot soaks increased the number of respondents in the normal category (>1.0) to 26 (86.7%), while those in the LEAD category (<0.9) decreased to 4 (13.3%), indicating improved blood circulation in the lower extremities.

This aligns with the International Diabetes Federation (IDF) diabetic foot management guidelines, which state that limited ankle joint mobility is directly related to high pressure on the feet and poor vascular perfusion. The IDF recommends leg muscle movement exercises such as walking and ankle ROM as part of primary prevention to improve peripheral circulation and maintain blood vessel elasticity in diabetes patients. This improved circulation is automatically reflected in improved ABI values (IDF, 2023). In addition, this study is also in accordance with the statement (WHO, 2022) in complementary medicine strategies recognizing the use of water (hydrotherapy) as a method to reduce pain and improve blood

circulation in patients with metabolic disorders such as diabetes mellitus, which is the main cause of decreased ABI values. Ankle-Brachial Index (ABI) values after a combination of ankle ROM exercises and warm foot soaks increased the number of respondents in the normal category (>1.0) to 26 (86.7%), while those in the LEAD category (<0.9) decreased to 4 (13.3%), indicating improved blood circulation in the lower extremities.

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Respondents at Citra Melati Kindergarten were predominantly girls (65.8%), and most were 5 years old (84.2%), the typical age range for kindergarten children. This composition reflects adequate cognitive and fine motor development readiness to participate in self-care skills learning, including tooth brushing.

Prior to the intervention, children's tooth brushing skills were in the moderate category (mean = 3.68 out of a maximum score of 4), indicating that children understood the basics of tooth brushing technique but had not yet mastered all aspects optimally, thus requiring a more effective learning approach.

Following the provision of the Siger-U Pocket Book, children's tooth brushing skills significantly improved to the very good category (mean = 7.84 out of a maximum score of 8), with consistent mastery of almost all indicators, demonstrating the effectiveness of this media in supporting dental health learning. 4. The results of the statistical test using the Wilcoxon Signed Ranks Test showed a significant effect ($p = 0.000 \leq 0.05$) of the Siger-U Pocket Book intervention on improving children's tooth brushing skills, so it can be concluded that this media has proven effective as an educational tool in improving dental and oral care skills in early childhood. The results showed that Structured Diabetic Foot Exercises significantly improved ABI values with a significance value of <0.002 . The ABI value improved by $1.67 + 0.802$ to $1.10 + 0.305$.

The results showed that Structured Diabetic Foot Exercises significantly improved foot sensitivity values with a significance value of <0.001 . The foot sensitivity value improved by $1.67 + 0.497$ to $1.30 + 0.466$.

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Authors' contribution

Each author contributed equally in all the parts of the research. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

Conflict of interest

No declare.

Ethical consideration

Not applicable.

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