



EFFECTIVENESS OF COMBINED RESISTANCE EXERCISE AND WARM WATER IMMERSION ON FOOT SENSITIVITY IN TYPE 2 DIABETES MELLITUS: A PRE-EXPERIMENTAL STUDY

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ABSTRACT	Keywords
Diabetes mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia. One complication in DM patients is diabetic ulcers that begin with peripheral neuropathy. This peripheral neuropathy causes decreased sensitivity in the feet. The purpose of this study was to determine the effect of a combination of resistance exercise and warm water soaks on the sensitivity values of the feet of diabetes mellitus patients. The research method used was quantitative with a Pre-Experimental design, namely One Group Pretest-Posttest design. Respondents were given an intervention in the form of resistance exercise and warm water foot soaks 3 times per week for 30 minutes. The population of this study were all type II Diabetes Mellitus patients under the management of the Blooto Health Center Work Area, Mojokerto City. The sampling technique used was purposive sampling with a sample size of 32 respondents. The results of the statistical test with the Wilcoxon Rank Test showed a p value <0.05, indicating that there was a significant difference in the sensitivity values of the feet before and after the intervention. The z value = -5.099 also strengthens the existence of significant changes with the direction of change indicating improvement.	Diabetes Mellitus, Combination of Resistance Exercise and Warm Water Soak, Foot Sensitivity

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia due to impaired insulin production, decreased insulin action due to insulin resistance, or both, leading to hyperglycemia. The most feared complication is diabetic ulcers, which can lead to amputation and mortality. Most foot ulcers begin as peripheral neuropathy.

(Roisiani et al., 2018). This peripheral neuropathy causes decreased sensitivity in the feet, so that people with diabetes mellitus often experience loss of sensation in the feet.

The International Diabetes Federation (IDF) stated that the number of global diabetes mellitus cases in 2021 was 537 million adults (20-79 years old) consisting of type 1 and type 2 diabetes. The incidence of Diabetes Mellitus cases is

estimated to increase by 643 million in 2030 and 783 million in 2045. According to the IDF, Indonesia is currently ranked 5th in the world with 19.5 million people suffering from DM, and is estimated to increase to 28.5 million people in 2045 (Azmi & Al, 2024). The Indonesian Ministry of Health (2022) stated that in Indonesia, there are 10.7 million people with type 2 diabetes from adulthood to old age. On the other hand, the East Java Basic Health Survey (2022) stated that 2.1% of 39,292,972 people in East Java have type 2 diabetes. (Devi et al., 2023). According to data from the Mojokerto City Health Office in 2024, there were 1,321 cases of diabetes mellitus in the Blooto sub-district. A preliminary study conducted with six patients revealed that three frequently experienced tingling and numbness in their feet.

One of the chronic complications that often occurs in diabetes patients is diabetic peripheral neuropathy, which is damage to the peripheral nerves that causes sensory, motor, and autonomic disorders. Sensory disorders generally occur symmetrically, causing gradual sensory loss and numbness. This neuropathy most often affects the lower extremities and can cause decreased foot sensitivity, tingling, pain, and even loss of sensation. As a result, patients are susceptible to diabetic foot ulcers and can lead to amputation.. (Rahayu et al., 2023). Therefore, efforts are needed to increase foot sensitivity to prevent further complications..

Several non-pharmacological approaches have been developed to help improve nerve function and foot sensitivity. One intervention that has proven effective is resistance exercise. This exercise can increase nitric oxide production, thereby reducing Schwann cell demyelization and sorbitol accumulation caused by chronic hyperglycemia, which can indirectly improve nerve cell conductivity. Resistance exercise can improve peripheral nerve function and enhance sensory perception in patients with diabetic neuropathy. (Suryawan et al., 2022).

Furthermore, soaking in warm water is also known to provide physiological

benefits, such as increasing blood flow to the extremities, relaxing muscles, and reducing joint stiffness. Warm water stimulates vasodilation of blood vessels, thereby increasing oxygenation and nutrition to peripheral tissues, including nerves. The loading factor in the water will strengthen the muscles and ligaments that affect the body's joints. (Kurnia & Fitri, 2023).

Resistance training and warm foot soaks can be considered self-care interventions to maintain the body's physiology and prevent complications. This is in line with Dorothe Orem's self-care theory, where nurses, as educators, play a crucial role in motivating diabetes mellitus patients to change their behaviors in a more positive direction. Diabetes mellitus patients must practice self-care practices to optimize their abilities to improve their health and quality of life (Sihaloho et al., 2024).

Several separate scientific studies on resistance exercise and warm foot soaks have been shown to have positive effects on patients with diabetes mellitus (DM). However, no integrated study has been conducted evaluating the combined intervention of resistance exercise and warm foot soaks in patients with diabetes mellitus within the context of primary health care at the Blooto Community Health Center. Easy-to-implement and inexpensive non-pharmacological interventions have the potential to improve clinical outcomes such as increased foot sensitivity or stable blood sugar levels, while reducing the need for additional medication. This evidence gap underscores the need for research to assess the effectiveness of the combination of resistance exercise and warm foot soaks as a rehabilitative approach to improving foot sensitivity in patients with diabetes mellitus.

METHOD

This study used a quantitative method with a Pre-Experimental design, namely One Group Pretest-Posttest design. The population of this study was all type II Diabetes Mellitus patients under the management of the Blooto Community Health Center Work Area in Mojokerto City with a research implementation time of ± 4 weeks (adjusted to research needs),

including the preparation stage, intervention implementation, and evaluation of results. The sampling technique used was purposive sampling with a sample size of 32 respondents. The respondent criteria in this study were:

Inclusion criteria

- 1) Type II diabetes mellitus patients experiencing impaired foot sensitivity
- 2) Patients experiencing skin perfusion pressure

Exclusion criteria

- 1) Type II diabetes mellitus patients with diabetic ulcers
- 2) Patients experiencing impaired physiological function (shortness of breath or chest pain)
- 3) Patients experiencing emotional conditions (depression, anxiety, or excessive worry)

The research instrument used was an observation sheet to measure foot sensitivity in the form of the Iswich Touch Test (IpTT). Foot sensitivity was assessed at 6 points on either the right or left toes, including the big toe, little toe, and middle toe. The interpretation of the measurement results is that the foot sensitivity value is normal if the patient is able to feel touch at 5 or 6 points. Sensation disorders occur if the patient is able to feel touch at 2 or 3 points. Patients experience Loss of Protective Sensation (LOPS) if they cannot feel touch and pressure at 2 or more points. The Iswich Touch Test (IpTT) instrument with a high level of accuracy, this test is very effective in detecting early symptoms of foot nerve damage due to Diabetes Mellitus (Dahrizal et al., 2023).

The procedure in this study was that respondents underwent an initial measurement of their foot sensitivity using the Iswich Touch Test (IpTT) instrument. Then, resistance exercise was performed on the lower extremities for 20-30 minutes, 3 times per week for 4 weeks. Warm water immersion was performed at a temperature of 37-40°C, for 15-20 minutes. The intervention was carried out in accordance with established Standard Operating Procedures (SOP). After the series of interventions was completed, the foot sensitivity value was measured again using

the same instrument. Researchers were assisted by enumerators in collecting research data.

The collected research data was then analyzed using univariate analysis to determine the frequency distribution of respondents' characteristics. Bivariate analysis was then conducted to determine the effect of the combination of resistance exercise and warm water immersion on the foot sensitivity scores of DM patients using the non-parametric Wilcoxon Rank Test.

RESULTS

Table 1. Distribution of respondent characteristics by Age, Gender, Duration of DM Suffering, and Comorbidities primary data sources 2025

No.	Respondent characteristics	F	%
1	Age		
	Middle Age	4	12.5
	Elderly	20	62.5
	Young Old	8	25.5
	Total	32	100
2	Gender		
	Male	7	21.9
	Female	25	78.1
	Total	32	100
3	Duration of DM Suffering,		
	< 5 years	20	62.5
	> 5 years	12	37.5
	Total	32	100
4	Comorbidities		
	There are comorbidities	25	78.1
	no comorbidities	7	21.9
	Total	32	100

Based on Table 1 shows the general characteristics of respondents based on age, gender, duration of DM and comorbidities in Diabetes Mellitus patients. Based on the table, most respondents are in the Elderly age group as many as 20 respondents (62.5%). Based on gender, the majority of respondents are women, namely 25 respondents (78.1%). Regarding the duration of DM, most

respondents have suffered from DM <5 years as many as 20 respondents (62.5%). Based on the history of comorbidities, it is known that most respondents have comorbidities as many as 25 respondents (78.1%).

Table 2. Results of the analysis of the effectiveness of the combination of resistance training and warm water immersion on foot sensitivity values. primary data sources 2025

No	Foot Sensitivity	Pre test		Post test		Statistical Test Results
		F	%	F	%	
1	Normal	0	0	20	62.5	p-value = 0,000 dengan nilai Z = -5.099 Median = 1
2	Sensational Disorders	25	78.1	13	40.6	
3	Loss of Protective Sensation (LOPS)	7	21.9	3	9.4	
	Total	32	100	36	112.5	

Table 2 shows that the Wilcoxon signed rank test results yielded a p-value of 0.001 ($p < 0.05$), indicating a significant difference between before and after the intervention. The z-value of -5.099 also confirms the significant change, with the direction of the change indicating improvement.

DISCUSSION

Based on Table 2, the descriptive analysis results show that out of the total sample of 32 respondents, after performing the combination of Resistance Exercise and warm water soaking, there was a change in foot sensitivity values towards a more positive direction, namely in the normal foot sensitivity category for 20 respondents (62.5%). The increase in foot sensitivity in this study is in line with the theory put

forward by Prameswari, Dita et al. in 2024, which stated that resistance exercise can reduce the inflammatory process and increase nerve regeneration, thereby improving nerve sensitivity in the foot area. In addition, this exercise can improve endothelial function, which is important in maintaining vascular health in people with Diabetes Mellitus. By doing resistance exercise regularly, it can help prevent the process of diabetic neuropathy and peripheral artery disease, which can reduce the quality of life of patients with Diabetes Mellitus. (Prameswari et al., 2024). In line with research conducted by Al Gifari et al in 2023, the results of the study showed that resistance exercise performed regularly can increase muscle mass and strength by improving cellular metabolism. (Al Gifari et al., 2023).

The resistance exercise method in this study was combined with a warm water soak on the feet, so that the two therapies synergize. Soaking the feet in warm water has a positive impact on blood vessels and stimulates nerve stimulation in the soles of the feet. The peripheral nerves in the soles of the feet are easily stimulated to transmit signals to the central nervous system through afferent and efferent nerve transmission, thereby improving sensitivity in the feet. (Maryama et al., 2021).

Based on the research results listed in Table 2, the results obtained from the Wilcoxon Signed Rank Test statistical analysis used to compare foot sensitivity values before and after the intervention showed a significant difference, with a p value of 0.001 ($p < 0.05$). The z value of -5.099 also indicates that the changes that occurred moved in a positive direction, namely an increase in foot sensitivity. This means that the combination therapy of resistance exercise and warm water immersion has an effect on improving the foot sensitivity values of Diabetes Mellitus patients.

The results of the study are in line with the research of Pratiwi, Rizky M in 2018, which showed that resistance exercise has an effect on diabetic neuropathy, namely sensory responses, foot protection sensations, autonomic responses, ankle

brachial index values, and dorsiflexion motor responses. By doing resistance exercise regularly, physiological adaptations will occur, namely the process of motor learning and improved coordination. Where there will be an increase in the number of motor units and nerve conduction velocity. In addition, the adaptation process occurs in muscles, soft tissues, metabolism, and vascular. (Pratiwi, 2018).

Resistance exercise combined with warm water soaks can have a mutually supportive effect, resulting in improved foot sensitivity in patients with diabetes mellitus. Warm water foot soaks improve blood circulation and reduce cramps and tingling sensations. Therefore, the combination of resistance exercise and warm water soaks has a more positive impact on improving foot sensitivity. (Permatasari et al., 2020). The combined effect of these two interventions can increase blood flow and improve sensory nerve function, as well as increase muscle strength, making the feet more sensitive to sensory stimuli. Soaking the feet in warm water relaxes the muscles and increases metabolic response.

Nurses play a strategic role in primary and secondary prevention, reducing the likelihood of diabetes complications. The combination of these two interventions has implications for improving sensory sensitivity in the feet, thereby reducing the risk of diabetic ulcers.

This study has several limitations. The pre-experimental design was unable to fully control for confounding factors such as dietary adherence, respondents' daily physical activity levels, and stable blood glucose levels during the study period. Furthermore, the sample size was relatively limited, confined to a single work area, making it difficult to generalize to all diabetes patients.

CONCLUSIONS

The combination of resistance exercise and warm water immersion has been statistically proven to improve foot sensitivity in patients with diabetes mellitus. The results of this study are expected to

inform independent nursing interventions through education on diabetic foot care for the community. Future research is expected to utilize randomized controlled trials (RCTs) to achieve better results and minimize confounding factors.

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