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# The Combination of Diabetic Foot Exercises and Warm Water Foot Soak for Unstable Blood Glucose Levels Nursing Problems in Elderly

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**ABSTRACT**

Diabetes mellitus is a vital health disease to pay attention to in the elderly population. When compared to individuals without diabetes, the older adult with DM loses muscle mass faster and has more comorbidities such as hypertension. Another common complication of diabetes is diabetic neuropathy, which causes tingling and numbness in the extremities. One method for managing diabetes is to combine diabetes foot exercises with a warm water foot soak. This study aimed to see how diabetic foot exercises and warm water foot soak affected blood glucose levels and foot sensitivity in the older adult with diabetes. This research was a case study, and the research subject was an older adult with diabetes mellitus. Random blood glucose levels and foot sensitivity were measured using a glucometer and monofilament test. Client's average blood glucose levels decreased from 239.25 mg/dL to 235.75 mg/dL. Foot sensitivity points have increased from 8 points on the right foot and 7 points on the left foot to 9 points on the right foot and 8 points on the left foot. A combination of diabetic foot exercises and warm water foot soak can reduce blood glucose levels and increase the sensitivity of the feet of older adults with diabetes. The combination of these two therapies can be complementary to pharmacological therapy for older adults with diabetes.

**Keywords:** Diabetes mellitus, Diabetic Foot Exercise, Warm Water Foot Soak

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## 1. INTRODUCTION

Older adults are 60 years old and over (Lumowa & Rayanti, 2024) and can experience decreased body organ function or degenerative conditions. Degenerative diseases are non-communicable and chronic diseases resulting from aging, which impact the decline in the function of

the body's organs. One of the degenerative diseases that the older adult can experience is diabetes mellitus (DM) (Fatihaturahmi et al., 2023). DM is a critical health condition for the older adult (American Diabetes Association, 2020). Type 2 DM is a diabetes caused by decreased insulin secretion in insulin-resistant beta cells (American Diabetes Association, 2022). Older adults with DM have faster rates of premature death, functional impairment, loss of muscle mass, and comorbidities such as hypertension, coronary heart disease, and stroke compared to those who do not have diabetes (American Diabetes Association, 2020). Another common complication of diabetes is diabetic neuropathy, which is characterized by tingling and numbness in the extremities (Oh, 2020).

According to Riskesdas in 2018, East Java was ranked fifth in the province with the highest prevalence of DM, at 2.6% (Kementerian Kesehatan RI, 2018). People living with diabetes in Banyuwangi Regency in 2021, according to the Banyuwangi Regency health profile, numbered 27,097 people (Dinas Kesehatan Kabupaten Banyuwangi, 2021) and increased in 2022 to 27,221 people (Dinas Kesehatan Kabupaten Banyuwangi, 2022). Based on the results of a study conducted by PSP2N students from the Gerontic Nursing Station, Faculty of Nursing, Jember University at UPT PSTW Banyuwangi, data was obtained that 6 out of 100 older adults had DM, and 16 older adults had hypertension. Previous research revealed that older adults with diabetes showed lower life expectancy and percentage of healthy life expectancy compared to older adults with hypertension, which is associated with diabetes patients having a higher risk of experiencing chronic complications, such as heart disease and stroke, as well as microvascular complications, namely retinopathy, nephropathy, and neuropathy (Liang et al., 2020). The attempts made by UPT PSTW Banyuwangi to overcome these two problems include providing routine pharmacological intervention with drugs according to predetermined doses. Research shows that many people living with diabetes focus more on managing diet and medication. However, these attempts must be balanced with appropriate physical exercise. One of these physical exercises is diabetes foot exercises to reduce blood glucose levels and improve blood circulation in the feet to reduce the risk of diabetes complications (Yulianti & Armiyati, 2023).

Diabetic foot exercises are associated with increased recovery of muscle glucose used as energy. When doing physical

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activity, muscles will take up glucose, causing a decrease in blood glucose levels and improving blood control (Putra et al., 2024). Leg exercises can help improve blood circulation and flow, allowing more capillary networks to open and more insulin receptors to become active and available. This condition will make it easier to deliver nutrients and oxygen to neurons, improving nerve function and increasing foot sensation. Diabetic foot exercises can also reduce symptoms of sensory neuropathy, such as tingling, pain, and numbness (Astuti et al., 2023). Warm water foot soak therapy can increase nitric oxide production. In contrast, increased nitric oxide production can restore insulin absorption by cells, which was previously decreased due to insulin resistance (Meza et al., 2019). The effect of warm water foot soaks on peripheral circulation is caused by the vasodilation mechanism in peripheral blood vessels, so that blood circulation runs smoothly (Putra et al., 2024) and can affect foot sensitivity and peripheral blood circulation in people with diabetes (Cahyandari & Ibrahim, 2024).

Diabetic foot exercises aim to improve blood circulation, strengthen the small muscles in the feet, prevent foot deformities, and overcome limitations in joint movement. Diabetic foot exercises have also reduced random blood glucose levels for people with diabetes diabetes (Arvita, 2024; Dihongo & Sonhaji, 2024). Foot exercises can also increase the sensitivity of the feet of diabetics, where people with diabetes are at risk of developing complications of diabetic neuropathy (Ariyanto et al., 2024; Arvita, 2024). Improving blood circulation can be done by soaking the feet in warm water. Previous research showed increased foot sensation in older adults with diabetes by providing warm water foot soak therapy (Permatasari et al., 2020). Other research shows that warm water foot soak therapy can reduce blood glucose levels in DM patients (Kurnia & Fitri, 2023). This study aims to determine the effect of a combination of diabetes foot exercises and warm water foot soaks on older adults with nursing problems of unstable blood glucose levels.

## 2. METHODS

This research uses a case study method, describing a case and assessing a specific situation. The subject of this research was a female older adult at UPT PSTW Banyuwangi who has had type 2 diabetes mellitus for 6 years and has a history of hypertension. The assessment showed that the random blood glucose levels were 236 mg/dL, considered hyperglycemia, and the client's blood

pressure was 159/90 mmHg. The client complains that she often feels tired and thirsty, sometimes feels pain in the back of the head that spreads to the neck and shoulders, and often feels tingling and stiffness in the left leg. The client experiences nursing problems of unstable blood glucose levels related to insulin resistance, which is characterized by several major signs, namely complaints of frequently feeling tired, often feeling thirsty, and high blood glucose levels, namely 236 mg/dL. It is possible that the tingling and stiffness experienced by the client are signs of peripheral neuropathy that people with diabetes can experience. This diabetic peripheral neuropathy is supported by several risk factors experienced by the client, including poor glycemic control, long duration of diabetes mellitus, increasing age, and the presence of hypertension (Sloan et al., 2021).

The research was carried out over 7 meetings using a combination of diabetes foot exercises and warm water foot soaks. The diabetes foot exercise intervention was performed for 15 minutes, followed by soaking the feet in warm water for 15 minutes. Random measurements of blood glucose levels and foot sensitivity were carried out 15 minutes before the intervention and 15 minutes after the intervention was given. Measurements were carried out every 2 days with a glucometer and 10 g monofilament.

## 3. RESULTS

The patient was a female older adult, 65, and had lived at UPT PSTW Banyuwangi for two years. During the assessment, the client complained that she often felt tired and thirsty, sometimes felt pain in the back of the head that spread to the neck and shoulders, and felt tingling and stiffness in the left leg. The client said she had diabetes mellitus for 6 years and admitted to having a history of hypertension. The client was hospitalized 6 years ago for diabetes with symptoms of feeling dizzy and weak. The results of the physical assessment of the client showed that the client's blood pressure was 159/90 mmHg, temperature 36.5 °C, pulse rate 84 x/ x/minute, RR 20x/minute, and random blood glucose level 236 mg/dL, which indicated the client was experiencing hyperglycemia. Because of the conditions that she experiences, the client routinely takes glibenclamide 1 x 5 mg and amlodipine 1 x 5 mg provided by UPT PSTW Banyuwangi. The client actively participates in various activities at UPT PSTW Banyuwangi, including physical, spiritual, entertainment, and other activities. These activities include gymnastics, recitation, karaoke, and

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others. Actions that clients usually take to relieve the complaints are resting and sleeping if they feel tired and have back headaches, frequently moving their left leg, and applying massage oil when they feel tingling.

The nursing diagnosis that emerged in the client was the instability of blood glucose levels related to insulin resistance, characterized by blood glucose levels of 236 mg/dL, complaining of frequent feeling thirsty and tired (D.0027). The client also experienced tingling and stiffness in the left leg, which could be a sign of peripheral neuropathy due to diabetes, which is supported by several risk factors for diabetic peripheral neuropathy experienced by the client, namely long duration of diabetes, poor glycemic control, increasing age, and hypertension. The primary nursing intervention given based on the client's nursing problem is hyperglycemia management (I.03115) by identifying possible causes of hyperglycemia, monitoring blood glucose levels, monitoring signs and symptoms of hyperglycemia, teaching diabetes management in the form of oral medication, diet, foot exercises, and warm water foot soaks, as well as collaboration in administering the drug glibenclamide.

This case study focuses on applying a combination of diabetic foot exercises and warm water foot soaks as complementary therapies for the problem of unstable blood glucose levels, especially for foot complaints experienced by the client. The combination of diabetic foot exercises and warm water foot soaks is carried out simultaneously for 7 days (14 April 2024 to 20 April 2024) at 09.30 WIB. The duration of diabetic foot exercises is 15 minutes, followed by a 15-minute warm water foot soak. The client's blood glucose levels and sensitivity are evaluated every two days.

The client complained of tingling in the left leg before the second implementation day. Complaints decreased after doing diabetic foot exercises and warm water foot soaks. The same complaints were felt on the third day and decreased after implementation. After combining both therapies on the seventh day, the client said he felt relaxed, the feeling of fatigue was reduced, and the stiffness and tingling experienced in the left leg decreased.

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**Table 1.** Client's blood glucose levels before and after the combination of diabetic foot exercises and warm water foot soak intervention

| Day | Blood Glucose Levels (mg/dL) | |
|---|---|---|
| | Pre-implementation | Post-implementation |
| 1 | 248 | 248 |
| 3 | 240 | 238 |
| 5 | 236 | 230 |
| 7 | 233 | 227 |
| Mean | 239,25 | 235,75 |

During diabetic foot exercises and warm water foot soaks, the client's random blood glucose levels are measured every two days. The measurement results showed a decrease in blood glucose levels after implementing this. The average blood glucose level of the client before and after implementation also changed; the average blood glucose level after implementation became 235.75 mg/dL, or decreased from the previous one of 239.25 mg/dL.

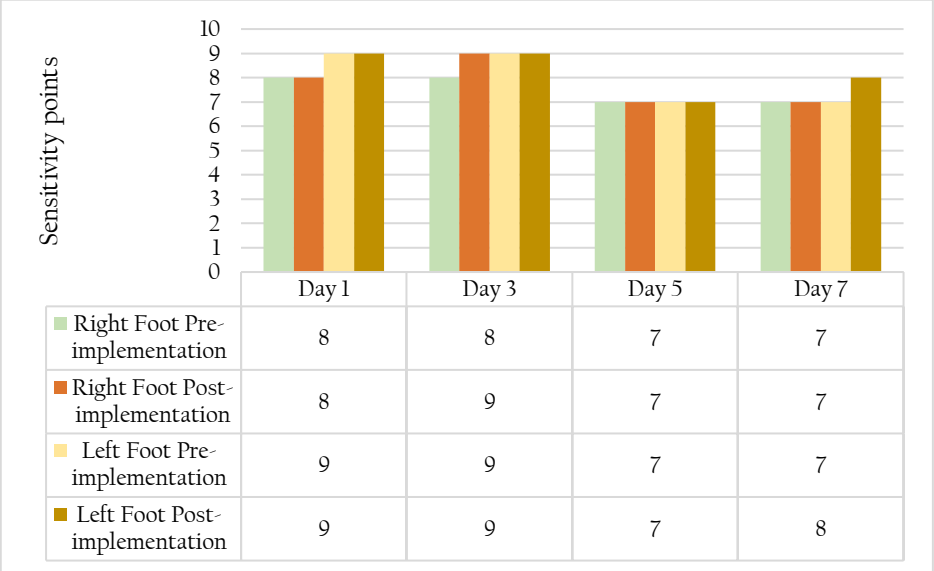


**Figure 1.** Sensitivity points before and after the combination of diabetic foot exercises and warm water foot soak intervention

The client also experienced increased foot sensitivity points after implementing diabetes foot exercise therapy and warm water foot soaks for seven days. The results of measuring the client's sensitivity on the first day of implementation showed that the client could feel 8 points on the right foot and 7 points on the left. The sensitivity points felt by the client then increased slowly until, on the seventh day of implementation, there was an increase in the points felt by the client, namely 9

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points on the right foot and 8 points on the left foot. The results show that the combination of diabetic foot exercises and warm water foot soaks can increase the sensitivity of the feet of diabetic clients.

## 4. DISCUSSION

The client does diabetic foot exercises and soaks her feet in warm water for seven consecutive days. There was a decrease in her random blood glucose levels during the combination of the two therapies. These results are in line with previous research, which showed that implementing a combination of diabetes foot exercises and warm water foot soaks for seven days in clients with diabetes mellitus was able to reduce blood glucose levels. The blood glucose level on the first day before the combined intervention was 577 mg/dL and decreased to 420 mg/dL on the seventh day after the intervention was done on the client. The decrease in blood glucose levels was also experienced by two other clients, namely the client's blood glucose level 2 decreased from 580 mg/dL to 513 mg/dL on the seventh day, and client 3's blood glucose level decreased from 380 mg/dL to 160 mg/dL (Kurnia & Fitri, 2023).

Research by Kurnia and Fitri (2023) suggests that a combination therapy intervention of foot exercises and warm water foot soaks can be a non-pharmacological therapy for people with diabetes to lower blood glucose levels. Physical exercise with diabetic foot exercises affects blood glucose due to increased use of glucose by muscles. The combination with warm water soaking triggers the release of nitric oxide as a vasodilator for blood vessels and can reduce blood glucose levels. In their research, Rosyid and Angraini (2022) stated an increase in energy needs by activating muscles during physical exercise. When muscles contract, membrane permeability increases, so insulin resistance decreases while insulin sensitivity increases. Physical exercise, one of which is diabetes foot exercises, can improve the regulation of blood glucose levels and cells.

Diabetic foot exercises, as a form of physical exercise, can be used as an alternative by the older adult to reduce blood glucose levels. As explained above, physical exercise is associated with increasing the speed of muscle glucose recovery or glucose intake, which muscles use as an energy source. Muscles utilize stored glucose, and when this glucose is reduced, the muscles will take glucose from the muscles when exercising or doing physical activity, causing a decrease in blood glucose levels and improving blood glucose control (Putra et al., 2024).

Patients diagnosed with diabetes mellitus should be instructed in an exercise program such as diabetic foot exercises because they focus on maintaining and increasing the range of motion in the ankles and feet. Moreover, through leg exercises, there is an increase in blood supply to the extremities, which also has an impact on maintaining blood glucose (Graciella & Prabawati, 2020). It can be assumed that diabetic foot exercises are a form of physical exercise that can reduce blood glucose levels in diabetes patients. When doing leg exercises, the muscles need an energy source of glucose from the muscles and glucose contained in the blood. The body converts glucose in the blood into an energy source. Therefore, blood glucose levels can decrease after doing diabetes foot exercises, which are included in physical exercise.

Besides doing diabetic foot exercises, the client also does warm water foot soaks. Warm water foot soak therapy can also reduce blood glucose levels; according to research, there is a significant difference between warm water foot soaks on the blood glucose levels of older adults with a p-value ‹ 0.05. The mean fasting blood glucose level before the warm water foot soak was 156.8 mg/dL and decreased to 136.7 mg/dL after the intervention (Ghosh et al., 2022). Warm water foot soak therapy can reduce blood glucose levels by increasing nitric oxide production (Mataputun et al., 2020). Nitric oxide is a molecule that plays a role in the vasodilation of blood vessels. The endothelium produces nitric oxide, where conditions of diabetes and hyperglycemia can cause endothelial dysfunction, so nitric oxide production decreases and can increase the role of endothelial dysfunction in vascular complications of diabetes (Maruhashi & Higashi, 2021). Increasing nitric oxide production can restore insulin absorption by cells, which was previously decreased due to insulin resistance (Meza et al., 2019). Therefore, soaking the feet in warm water can increase the production of nitric oxide, which helps increase insulin sensitivity in cells.

The client's foot sensitivity was also evaluated after doing diabetic foot exercises and soaking his feet in warm water for seven days. After carrying out the combination therapy for seven days, the client experienced increased foot sensation or sensitivity. On the first day before the intervention, the client could feel 8 points on the right foot and 7 on the left. Increased sensation occurred with 9 points on the right foot and 8 on the left. These results are similar to the research by Permatasari et al. (2020), which showed an increase in the

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average foot sensitivity score after therapy from 5.28 to 7.09.

Diabetic foot exercises, as a form of physical exercise, can reduce oxidative stress and increase neurotrophic factors. Diabetic foot exercises trigger energy formation and increase Na+ / K+ ATP activity; then, there is an increase in axonal transport so that the individual will feel sensory sensations (Sukartini et al., 2019). Leg exercises can also help improve blood circulation and flow, allowing more capillary networks to open and more insulin receptors to become active and available. This condition will make it easier to deliver nutrients and oxygen to neurons, improving nerve function and increasing foot sensation. Diabetic foot exercises can also reduce symptoms of sensory neuropathy, such as tingling, pain, and numbness (Astuti et al., 2023).

However, it should be noted that soaking the feet in warm water is a form of heat stress for the body. During heat stress, human temperature regulation depends on adequately increasing heat loss through sweating and skin vasodilation. When the skin experiences heat stress, temporal vasodilation of blood vessels occurs (Cramer et al., 2022). This is supported by the findings of Cheng and MacDonald (2019), who concluded that there is a possibility that microvascular function can improve. Blood vessels experience vasodilation when receiving heat therapy, such as a warm water soak. However, this temporary or acute heat affects the blood vessels. This possibility is because the literature regarding the acute vascular response to heating is still limited, and the results are still equivocal.

The confounding factor in this study was the consumption of medication to reduce the client's blood glucose levels, namely glibenclamide 1 x 5 mg as a drug to control diabetes mellitus. Glibenclamide is a sulfonylurea drug that increases insulin production from beta cells (Kementerian Kesehatan RI, 2019). Based on the study results, it is known that the client takes glibenclamide every day. The results of evaluating the client's random blood glucose levels show a decrease in blood glucose levels every two days, but in small amounts. This result differs from research (Sola et al., 2015), which states that sulfonylurea drugs can reduce blood glucose concentrations by around 20%. Administering medication is needed as one of the four pillars of controlling diabetes mellitus and regulating diet and physical exercise (Perkumpulan Endokrinologi Indonesia, 2021). Therefore, there is a need to examine further the client's compliance with taking medication, consideration of

other oral diabetes medications, and monitoring of the diabetes diet.

Another confounding factor is the interval between the combined intervention of diabetic foot exercises and warm water foot soaks and the measurements after the intervention. Measurements or evaluations are carried out 15 minutes after the combination of interventions. Based on a scientific article by Soo et al. (2023), there is glucose transport activity in skeletal muscle during physical exercise, where the increase in glucose transport rate persists up to 10, 30, 60, and 180 minutes after exercise, compared to before exercise. When glucose transport occurs, insulin sensitivity, which is influenced by insulin concentration, also changes. The duration of increased insulin sensitivity after exercise can last between 3 and 48 hours and depends on dietary status.

The same thing can be said for soaking the feet in warm water. The duration of immersion and measurement time after intervention may contribute to the study results, which were compared in a review (Cheng & MacDonald, 2019). The first study obtained improved microvascular function results after 45 minutes of immersion in warm water (Romero et al., 2017), while the second study measured the degree of arterial stiffness, which decreased after soaking in warm water but returned to its original level after 30 minutes (Hu et al., 2012). It is assumed that the duration of the intervention and the timing of random blood glucose measurements, as well as the sensitivity of the feet after this combination of therapy, can influence the measurement results.

## 5. CONCLUSION

Based on the results and analysis of the implementation of a combination of diabetic foot exercises and warm water foot soaks in older adults with diabetes, it can be concluded that there was a decrease in the average random blood glucose level and an increase in foot sensitivity on seven consecutive days of implementation. Changes in mean blood glucose levels decreased from 239.25 mg/dL before implementation to 235.75 mg/dL after implementation. The sensitivity of the client's feet also increases, namely from 8 points on the right foot and 7 points on the left foot to 9 points on the right foot and 8 points on the left foot. It is assumed that nursing care for older adults with problems with blood glucose instability that focuses on a combination of diabetic foot exercises and warm water foot soaks can be applied as an accompanying therapy. Personal nursing care for older adults living in

nursing homes is essential to pay attention to because each older adult has different conditions.

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## AUTHOR CONTRIBUTIONS

LPA: conceptualization, validation process, research and investigation, writing original draft, review, and editing process. LPA and FK: conceptualization, writing process, including review and editing. LPA and NKA: writing process and review.

## CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

## DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available upon reasonable request from the corresponding author.

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