

## The Impact of Foot Solus Per Aqua (SPA) on Blood Sugar Levels and Parasthesia Sensitivity in Patients with Diabetes Mellitus Type 2

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### Abstract

People with Diabetes Mellitus (DM) type 2 who lead poor lifestyles may experience blood glucose instability and develop diabetic neuropathy, a condition where nerve damage results from the disease. Decreased sensation, pain, and paresthesia, as well as muscle weakness and excessive foot sweating that leaves the feet dry and easily cracked, are some of the signs of diabetic neuropathy. This study contributed to elucidating how Foot Solus Per Aqua (SPA) affected changes in blood sugar levels and paraesthesia sensitivity in patients in the Karang Gayam Wetan RW 02 area, Mojo Village, Gubeng District, Surabaya City, who were diagnosed with type 2 Diabetes Mellitus.

This study employs pre-experiment designs with one group pretest-posttest and a sample of thirty respondents. Additionally, a glucometer will be used to measure the respondents' sensitivity to paraesthesia, and a 10-gram monofilament test will be used to gauge their level of sensitivity. After that, two 30-minute foot solus sessions per week will be conducted as part of aqua therapy. Random glucose levels and paraesthesia sensitivity tests will be re-observed in the respondents following four weeks of foot solus per aqua therapy. The Mc Nemar test was used to analyze the data, with  $\alpha=0.05$  ( $p<\alpha$ ). The findings indicated that Foot Solus Per Aqua (SPA) had an impact on the stability of blood sugar levels with a p-value of 0.004. However, as shown by the p values of 0.008 on the right foot and 0.003 on the left, sensitivity to paresthesia is insufficient. The study's findings suggest that increasing daily activity and performing diabetic foot exercises five to seven times a day are essential for maintaining blood glucose stability within normal ranges and preventing paresthesia sensitivity.

**Keywords:** Blood Sugar Level, Diabetes Mellitus, Foot Solus Per Aqua (SPA), Paresthesia Sensitivity

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### 1. Introduction

Modern lifestyles with many food choices and an unhealthy way of life are increasingly spreading throughout society, causing degenerative diseases. The poor lifestyle of people with DM can cause instability in blood glucose levels and trigger the onset of nerve damage due to DM, namely diabetic neuropathy. Lack of foot hygiene and not using footwear during activities can risk ulcers in the foot area. One of the symptoms of diabetic neuropathy is a decrease in sensation, pain, and paresthesia, muscle weakness, sweating of the feet so that the feet are dry and easily cracked ([Gibbons, 2020](#)). Patients with severe DM undergo amputation of limbs due to decay (gangrene). Many people with type 2 DM still do not understand the importance of taking care of the foot area in preventing diabetic ulcers or even gangrene wounds.

Diabetic neuropathy is one of the many complications that occur in patients with type 2 diabetes mellitus. Diabetic neuropathy causes

nerve damage, especially in the feet and causes impaired walking function. About 20-30% of patients with type 2 diabetes mellitus suffer from neuropathic pain ([Lin et al., 2020](#); [Thomas et al., 2019](#)). Based on a preliminary study, data obtained that 5 out of 7 people with type 2 diabetes mellitus in the Karang Gayam Wetan area, Mojo Village, Gubeng Subdistrict, Surabaya experienced paresthesia sensitivity on the feet. One of them is a tingling sensation like needling, heat (burning) and arises during activity or after activity with a time span of 10-15 minutes.

Diabetes mellitus (DM) is brought on by insufficient insulin production by the pancreas or inefficient insulin utilization by the body ([Bistara et al., 2022](#)). If a person's blood glucose is more than 200 mg/dl, they are considered to have diabetes. Insulin target cells malfunction or are unable to respond to insulin as intended, which results in type 2 diabetes mellitus ([Susanti & Bistara, 2023](#)). Glucose is a source of energy for the body that comes from carbohydrates

absorbed through the intestines and glucose from the production of hepar, the absolute increase in blood glucose levels will stimulate the release of insulin. This condition causes instability of blood glucose levels in the body. Lack of glucose as well as lack of oxygen will result in impaired brain function, tissue damage such as peripheral neuropathy ([Ye et al., 2022](#)). Prolonged peripheral neuropathy damage will reduce the level of Parasthesia Sensitivity resulting in symptoms of tingling, pain, numbness, or weakness especially in the lower extremities, namely the feet. Decreased Parasthesia Sensitivity can lead to the occurrence of foot injuries without being known and felt by people with diabetes mellitus. Diabetes mellitus (DM) basically does not cause death, however, this disease can trigger various complications that cause disability and death. Some of the complications that may occur in people with DM are heart disease, kidney failure, amputation, blindness, depression and neurological disorders. Heart disease is a complication of DM that causes the most [deaths](#) ([Viigimaa et al., 2020](#); [Hafid et al., 2020](#)).

Diabetes Mellitus control can be managed with the 4 pillars of Diabetes Mellitus guidelines, which consist of education, diet, exercise, and medication adherence. Medication therapy can be given if education, diet, and exercise cannot control blood glucose levels within the normal range. In type 2 DM, insulin therapy can be given as a long-term therapy in controlling blood glucose levels ([Haider et al., 2020](#); [Rosenstock et al., 2020](#)). This risk can be minimized with one of the alternatives, namely foot SPA therapy, which includes foot exercises, foot soaks with warm salt water, and foot massage. Foot SPA can increase glutathione metabolism, glutathione is a cell antioxidant to prevent oxidative damage. The combination of foot SPA is expected to accelerate the reduction of diabetic peripheral neuropathy, especially increased sensation ([Ainiyah et al., 2022](#)).

The description of the facts above states that it is necessary to use these techniques because they can improve blood circulation in the feet and increase sensitivity in the feet in overcoming the risk of wounds on the feet of people with Diabetes Mellitus ([Dewi & Hinchliffe, 2020](#)). This study intends to continue previous research, namely "Foot SPA Effectively Improves Diabetes Foot Sensation", "The Effect of SPA Therapy and Diabetic Foot Gymnastics on Diabetic Peripheral Neuropathy Patients", and "The Effect of Foot Massae on Sensesai Protection on the Feet of Type 2 Diabetes Mellitus Patients with Diabetic Peripheral Neuropathy". The researcher's interest in studying the impact of Foot Solus Per Aqua (SPA) on blood sugar fluctuations and parasthesia sensitivity in

individuals with type 2 diabetes stems from the preceding description.

## 2. Method

This research method uses a pre-experimental design with a one-group pre-posttest design approach. This research was conducted from February 2023 to April 2023 with a period of approximately 4 weeks in the Karang Gayam RW 02 area, Mojo Village, Gubeng District, Surabaya City, East Java Province with a sample of 30 people and sampling using simple random sampling.

The independent variables in this study were foot solus per aqua (SPA) and In this study, blood glucose levels and parasthesia sensitivity were the dependent variables. The instruments used in collecting data for this study were a glucometer, monofilament test, clock and observation sheet. Interventions carried out include respondents being given foot solus per aqua therapy for 30 minutes. Foot exercises for 15 minutes, foot soak for 7 minutes, massage for 8 minutes (done 2x in one week), after doing foot solus per aqua for 8x in 4 weeks, then measuring blood glucose levels and measuring paraesthesia sensitivity again. Following the collection of the measurement findings, the researcher will examine the information. In this study using non-parametric statistical tests. To test the hypothesis, statistical analysis was carried out using the Mc. nemar statistical test formula at the 95% confidence level ( $\alpha = 0.05$ ). Research ethics is a process that entails social, legal, and professional obligations for research participants. Before conducting this study, researchers informed respondents in addition to following ethical guidelines.

This research has been reviewed by the Ethics Committee of STIKES Adi Husada under number 87A/01/EC/I/2023. Respondents were contacted by researchers to explain the findings. Included in the explanation were the following: protecting the privacy of data, compensating for unexpected events, rewards and hazards associated with the research, processes followed, and the researcher's responsibilities. Once again, the researcher inquired if anyone would be interested to take part in the study. Informed consent was requested from respondents as primary data was gathered. Following confirmation that all the data is complete, it will be processed and evaluated in accordance with the goals of the study.

### 3. Results and Discussion

#### Univariate analysis

The results of research conducted on respondents obtained general data results as follows:

**Table 1 Characteristics of Respondents Based on General Data**

Characteristics	Treatment Group	
	F	P (%)
<b>Age</b>		
Age 36-45 years	0	0%
Age 46-55 years	14	46,7%
Age 56-65 years	16	53,3%
Total	30	100%
<b>Gender</b>		
Man	12	40%
Woman	18	60%
Total	30	100%
<b>Education</b>		
Elementary School	3	10%
Junior High School	6	20%
Senior High School	18	60%
College	3	10%
Total	30	100%
<b>Medication Routine</b>		
Routine	17	56,6%
Not a routine	13	43,4%
Total	30	100%
<b>Long Suffered</b>		
>5 years	16	53,3%
<5 years	14	46,7%
Total	30	100%
<b>Knowledge</b>		
Good	21	70%
Less	9	30%
Total	30	100%

The results of the study in table 1 show that most of the respondents had diabetes mellitus aged 56-65 years, totaling 16 people or 53.3%. The age range of respondents is in accordance with the theory which states that age is a risk factor for diabetes mellitus. An increased age also increases the chance of having diabetes mellitus. Perrin asserts that the incidence of DM rises with increasing age. Age reduces one's ability to tolerate glucose. elevated blood glucose levels in elderly adults with insulin resistance brought on by dietary modifications, altered body composition, decreased exercise, and impaired neurohormonal function (Perrin et al., 2021).

Gender characteristics in table 1 obtained data for respondents who were male 12 people or 40%, while for respondents who were female 18 people or 60%. Diabetes mellitus affects women more frequently than it does males. Mubarrok claims that this is because of a drop in estrogen hormone levels brought on by menopause. Progesterone helps to stabilize blood sugar levels and facilitates the use

of fat as energy, while estrogen primarily maintains blood sugar balance and increases fat storage (Alemany, 2021). Insulin causes the hormone estrogen to react. Because blood glucose levels fluctuate after menopause due to changes in hormone levels, women are more likely than males to develop diabetes (Perrin et al., 2021).

#### Bivariate Analysis

The results of research conducted on respondents based on blood sugar levels before and after Diabetic Foot SPA, the following results are obtained:

**Table 2 Characteristics of Respondents Based on Blood Glucose Levels in Patients with DM Type 2**

Variable	Pre		Post	
	F	P (%)	F	P (%)
<b>Blood glucose levels</b>				
Normal	18	60%	27	90%
hypoglycemia	12	40%	0	10%
Hyperglycemia	0	0%	3	0%
Total	30	100%	30	100%
Test Wilcoxon	Results			
Signed Rank Test	P value = 0,004			

The results of the study illustrated in table 2 show that most respondents had normal blood glucose levels as many as 18 people (60%) before being given the intervention and respondents had normal blood glucose levels increased by 27 people (90%) after being given foot SPA therapy for 30 minutes (2x therapy in a week), including 15 minutes of foot gymnastics, 7 minutes of foot soak, 8 minutes of massage, the researcher measured blood glucose levels after being given the treatment. This demonstrates that the participants who received the diabetic foot SPA intervention or treatment had reduced blood sugar levels. The reduced blood sugar number shows how blood sugar levels have improved following diabetic foot SPA. Because blood sugar levels that are consistently high and surpass the normal threshold value are a sign of severe diabetes mellitus, a drop in blood sugar levels also signals a drop in the severity of diabetes problems.

The majority of the DM exercise participants had lower blood glucose levels, according to the study's findings. The main finding that unites the research done with this study is that giving gymnastic exercises or activities—of which gymnastics is one of several activities from the Diabetic Foot SPA—to patients with diabetes mellitus results in a drop in blood sugar. The primary distinction between the research and the study is that, whereas Hasanah's research involved diabetes gymnastics, this study focused on diabetic foot SPA activities, which included a diabetic gymnastics intervention. The aforementioned research' findings indicate that persons with diabetes mellitus typically have better control over or a reduction in their blood sugar levels when they engage in physical activity. The actions taken need to be executed precisely,

consistently, and with measurement. When diabetic foot spa exercises are done consistently, blood vessels may be stimulated more smoothly, and perspiration can be released until the pancreas produces less insulin, which lowers blood glucose ([Suryani et al., 2021](#)).

**Table 3 Characteristics of Respondents Based on Paresthesia Sensitivity in Patients with Diabetes Mellitus Type 2**

		After Right Leg Sensitivity	
		(+)	(-)
Before	(+)	18	0
Right Leg Sensitivity	Percentage	54,55%	0%
	(-)	8	7
	Percentage	24,24%	21,21%
		After Left Leg Sensitivity	
		(+)	(-)
Before	(+)	21	0
Left Leg Sensitivity	Percentage	63,64%	0%
	(-)	7	5
	Percentage	21,21%	15,15%
Uji Mc Nemar (p-value: 0,000)			

The results showed that based on the Mc.Nemar statistical test with  $p = 0.00$ , which means  $p < \alpha$  ( $\alpha = 0.05$ ), it means that there is an Effect of Foot Solus Per Aqua (SPA) on Changes in Blood Sugar Levels and Paresthesia Sensitivity in Patients with Type 2 Diabetes Mellitus in the Karang Gayam RW 02 area, Mojo Village, Gubeng District Surabaya.

The improved blood sugar levels following diabetic foot SPA are indicated by the reduced or decreasing blood sugar values. Because blood sugar levels that are consistently high and surpass the normal threshold value are a sign of severe diabetes mellitus, a drop in blood sugar levels also signals a drop in the severity of diabetes problems. A condition called "leg sensitivity" can be brought on by uncontrolled blood sugar levels.

Leg sensitivity is influenced by various factors such as insulin-independent diabetes mellitus (DMTTI), which is not well understood. It is believed that hereditary factors contribute to the development of insulin resistance. The non-insulin dependent type of diabetes (DMTTI) is characterized by a well-known pattern ([Nadrati et al., 2020](#); [Pebrianti et al., 2020](#)). Anomalies in insulin action and secretion are hallmarks of DMTTI. At first, it seems that the target cells are resistant to insulin's effects. Insulin increases the transport of glucose across the cell membrane by initially binding to specific cell surface receptors. This is followed by intracellular processes. There are anomalies in the way insulin binds to receptors in TTI patients. A decrease in the quantity of insulin-

responsive receptor sites on the cell membrane could be the cause of this. The insulin receptor complex and the glucose transport system are abnormally coupled as a result. Long-term maintenance of normal glucose levels can boost insulin secretion; nevertheless, eventually, circulating insulin secretion is insufficient to sustain euglycemia ([Winn et al., 2022](#)). Non-insulin dependent diabetes mellitus (NIDDM) is another name for type II diabetes mellitus, a heterogeneous collection of milder forms of diabetes that is primarily prevalent in adults but can also occasionally develop in children ([Ilonen et al., 2019](#)).

Diabetic foot exercises are exercises or movements performed by both feet alternately or simultaneously strengthening or flexing the muscles in the lower leg area, especially the ankles and toes ([Susanti, 2019](#)). Individuals with Diabetes Mellitus (DM) should attempt to control their disease and prevent risk factors for complications by nurturing a healthy lifestyle, since Hasanah claims that these disorders are frequently observed in individuals who do not lead a healthy lifestyle. Diabetes mellitus patients' bodies are unable to utilise insulin efficiently or create enough of it, which leaves them with an excess of sugar in their bodies. Uncontrolled DM will cause several complications that can be fatal, including leg amputation due to circulatory failure ([Tiwari, 2023](#)).

The blood circulation system is one of the important systems as a means of tissue perfusion. Disorders of the peripheral circulation system are also dangerous because minor complaints that arise are likely to interfere with daily activities. Severe clinical manifestations can interfere with the patient's performance, affect their productivity, and can even cause death. Circulatory system disorders are quite common in patients with Diabetes Mellitus (DM). These complications are mostly related to metabolic changes, especially hyperglycemia. Vascular damage is a typical symptom as a result of DM, and is known as angiopathy (macrovascular damage) usually appears as clinical symptoms in the form of ischemic heart disease and peripheral blood vessels ([Munteanu et al., 2022](#); [Perrin et al., 2021](#)).

Advanced diabetic foot conditions that are not treated properly can lead to foot amputation. Patients with diabetes mellitus will experience sensory nerve damage first. Sensory nerve damage causes impaired sensation of touch, temperature and pain. Research on tactile sensation disorders conducted by [Suryani et al.](#) in 2021, using a ballpoint tip that produces qualitative data. The study showed that there was an effect of diabetic foot exercises on measuring foot sensitivity with a ballpoint tip. The findings of the current study indicate that there is no effect because respondents do not do it regularly and periodically. The habits and behavior of sufferers such as not maintaining foot hygiene and not using

footwear during activities eventually make the soles of the respondents' feet thicken (Suryani et al., 2021).

#### 4. Conclusions and suggestions

Diabetic Foot SPA therapy is effective for maintaining stable blood glucose levels but has a less significant effect on the incidence of paresthesia sensitivity because respondents do not perform foot SPA regularly and periodically. In addition, it is also influenced by the habits and behavior of patients, such as not maintaining foot hygiene and not using footwear during activities. Recommendations for further research are to carry out continuous monitoring using the health promotion model theory approach to increase knowledge so that the results can be used as independent interventions by nurses and patients can do it themselves at home to improve physical health, especially foot sensitivity in chronic diabetes mellitus patients.

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