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Effectiveness of Orem's Theory-Based Diabetic Foot SPA on Glycemic Control and Peripheral Neuropathy in Type 2 DM

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Abstract

Type 2 DM remains a challenge both globally and nationally, due to the high incidence of diabetic foot ulcers and patients with uncontrolled glycemia. This is due to poor self-care for foot care and glycemic control. Not treating them quickly will increase lifelong disability, depression, quality of life, and risk of death. Diabetic foot spa based on Orem Theory was tested for glycemic management and peripheral neuropathy in type 2 DM patients. The purpose of this study was to determine the effectiveness of diabetic foot spa based on Orem's Theory on glycemic control and reduction of peripheral neuropathy symptoms in patients with type 2 DM in the work area of East Denpasar Health Center I. This study used a pre-post quasi-experimental design with a control group of 64 respondents with a diagnosis of type 2 DM consisting of 32 control groups given foot exercises and 32 intervention groups given diabetic foot spa. Translated with DeepL.com (free version) Glucose meter, neuropathy symptom score (NSS) questionnaire, and 10 mg monofilament were used. This study consisted of univariate and bivariate analysis. Bivariate analysis used Dependent and Independent t-test to see the difference before and after diabetic foot spa intervention. The results showed that the effectiveness of diabetic foot spa in the intervention and control groups using independent t-test obtained a p-value <0.05 which states that diabetic foot spa is effective in controlling glycemia and reducing peripheral neuropathy in patients with type 2 DM. The conclusion of this study is that diabetic foot spa based on Orem's Theory is effective in controlling glycemic and reducing symptoms of peripheral neuropathy in patients with type 2 DM.

Keywords: Diabetic Foot SPA, Glycemic Control, Peripheral Neuropathy, Type 2 DM.

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1. INTRODUCTION

Type 2 diabetes mellitus (T2DM) remains a global and national challenge, with major complications such as peripheral neuropathy and diabetic foot ulcers that increase the risk of amputation and mortality (Asgary et al., 2023; Astuti et al., 2023). Globally, 30%-50% of T2DM patients experience peripheral neuropathy by Hicks et al., (2019) and approximately 25% of them develop diabetic foot ulcers (Petersen et al., 2020). In Indonesia, 30% of T2DM patients suffer from diabetic foot ulcers, with a mortality rate reaching 32% (Kemenkes RS Sardjito, 2023). Denpasar City has the second-highest prevalence of T2DM in Bali, at 6.2% (Dinas Kesehatan Provinsi Bali, 2020). Data from January to March 2024 indicate an increase in T2DM cases at Puskesmas Denpasar Timur I, rising from 112 to 250 patients.

Previous studies indicate that peripheral neuropathy often develops unnoticed due to a lack of patient awareness regarding foot care (Amelia et al., 2019). The management of T2DM typically involves pharmacological therapy; however, long-term use can cause side effects such as gastrointestinal disturbances and kidney failure (Adiputra, 2023). Therefore, non-pharmacological therapy, such as diabetic foot spa therapy, serves as an alternative that can help control blood sugar levels and alleviate peripheral neuropathy symptoms (Wardani et al., 2019).

Several studies have examined the effectiveness of diabetic foot therapy with varying results. A study by Sukarja & Sukawana, (2020) found that foot spa therapy for six weeks improved oxygen saturation. Research by Embuai et al., (2019) discovered that diabetic foot therapy for three months enhanced vascular health. However, other research found that foot therapy performed five times a week for 15-30 minutes was ineffective in reducing peripheral neuropathy symptoms or fasting blood glucose levels after two weeks (Graciella & Prabawati, 2020).

The research gap lies in the inconsistency regarding the effectiveness of diabetic foot spa therapy in controlling glycemic levels and peripheral neuropathy, as well as the limited use of the Neuropathy Symptom Score (NSS) instrument to measure peripheral neuropathy symptoms. This study innovates by incorporating diabetic foot spa therapy based on Orem's Self-Care Theory, which emphasizes self-care as a primary factor in T2DM management (Alligood, 2018). Another innovation includes the use of Virgin Coconut Oil (VCO) in massage therapy, which helps moisturize the feet and prevent diabetic foot ulcers. With this approach, diabetic foot spa therapy is expected to be a more effective intervention for improving glycemic control and reducing peripheral neuropathy symptoms in T2DM patients. The purpose of this study was to determine the effectiveness of diabetic foot spa based on Orem's Theory on glycemic control and reduction of peripheral neuropathy symptoms in patients with type 2 DM in the work area of East Denpasar Community Health Center 1.

2. RESEARCH METHOD

This study used a quasi-experimental pre-post control group design. From the working area of East Denpasar Community Health Center 1, all type 2 DM patients were studied. The Sample Size Determination in Health Studies application of Lwanga and Lemeshow (1991) helped calculate the sample size. The participants in this study were 32 people in the intervention group given diabetic foot spa and 32 people in the control group given diabetic foot exercise. Inclusion criteria were patients diagnosed with type 2 DM in the East Denpasar Community Health Center 1 working area, aged 45-65 years, and willing to sign informed consent. Exclusion criteria are patients who experience a limited range of motion in the lower extremities, resign during the study and patients who smoke and consume alcohol. This study used non-probability sampling, namely consecutive sampling. Instruments including the Easy Touch brand Glucometer, 10 mg Monofilament, and Neuropathy Symptom Score were used to collect data and assess blood sugar levels and symptoms of peripheral neuropathy. Univariate

and bivariate analyses were used. While univariate used frequency distribution, bivariate used paired and independent t-test to determine the effectiveness of diabetic foot spa on glycemic control and peripheral neuropathy symptoms before and after administration. The Ethics Committee of ITEKES Bali and Bali Provincial Health Office approved this study with ethical numbers 04.0246/KEPITEKES-BALI/VI/2024 and DL.02.02.2249.TU.VI.2024.

3. RESULTS AND DISCUSSION

Table 1. Age of Type 2 DM Patients at East Denpasar Health Center I (n=64).

Indicators	Intervention		Control		p-value
	Frequency (f)	Percentage (%)	Frequency (f)	Percentage (%)	
Age (years)					
46-55	15	46.9	15	46.9	0.810
56-65	17	53.1	17	53.1	
Mean	1.531		1.531		
SD	0.507		0.507		

Table 1 shows that 17 (53.1%) of intervention and control group respondents are 56–65 years old. The mean±SD value is 1.531±0.507 for both the intervention and control groups.

Table 2. Frequency Distribution of Type 2 DM Patients at East Denpasar Health Center I (n=64).

Indicators	Intervention		Control		p-value
	Frequency (f)	Percentage (%)	Frequency (f)	Percentage (%)	
Gender					
Male	18	56.2	16	50	0.486
Female	14	43.8	16	50	
Education					
Primary school	1	3.1	2	6.2	0.773
Junior high school	5	15.6	6	18.8	
High school	14	43.8	16	50	
Higher education	12	37.5	8	25	
Duration of DM					
< 5 year	17	53.1	17	53.1	0.125
5-10 year	13	40.6	15	46.9	
> 10 year	2	6.3			
Job					
Self-employed	5	15.6	5	15.6	0.579
Eentrepreneur	8	25.0	6	18.8	
Civil servant	6	18.8	5	15.6	
Trader	4	12.5	8	25.0	
Housewife	7	21.9	3	9.4	
Not working	2	6.2	5	15.6	

Table 2 shows that the gender-wise, the intervention group contained 18 (56.3%) males and the control group 16 (50.0%) women. High school education was the majority for 14 (43.8%) in the intervention group and 16 (50.0%) in the control group. Most respondents, 17 (53.1%) in both intervention and control groups, had type 2 DM for <5 years. In the intervention group, 8 (25%) were self-employed and in the control group, merchants. The homogeneity test using Levene Statistic demonstrates that all respondent attributes (age, gender, education, duration of DM, and employment) have a p-value> 0.05, indicating homogeneity.

Table 3. Normality and Homogeneity Test of Glycemic Control and Peripheral Neuropathy (n=64).

Characteristics	Group	Intervention		Control		Homogeneity (p-value)
		Mean (SD)	Min-Max	Mean (SD)	Min-Max	
Glycemic Control	Pre -test	145.0 (9.382)	129-160	145.0 (8.169)	130-159	0.408
	Normality (p-Value)		0.093		0.139	
Glycemic Control	Post-test 1	142.9 (9.278)	128-159	143.7 (7.946)	130-159	0.365
	Normality (p-Value)		0.068		0.114	
Glycemic Control	Post-test 2	138.9 (9.378)	124-157	141.2 (7.433)	(127-156)	0.208
	Normality (p-Value)		0.215		0.631	
Glycemic Control	Post-test 3	131.3 (7.622)	119-153	137.8 (7.678)	124-151	0.762
	Normality (p-Value)		0.247		0.061	
Glycemic Control	Post-test 4	124.0 (7.487)	112-149	133.2 (7.076)	121-147	0.466
	Normality (p-Value)		0.016		0.090	
Peripheral neuropathy	Pre -test	6.781 (1.069)	4-8	6.593 (0.979)	5-8	0.758
	Normality (p-Value)		0.080		0.102	
Peripheral neuropathy	Post-test 1	6.156 (1.080)	3-8	6.406 (0.910)	4-8	0.616
	Normality (p-Value)		0.077		0.053	
Peripheral neuropathy	Post-test 2	5.125 (1.237)	3-8	5.968 (0.932)	4-8	0.091
	Normality (p-Value)		0.216		0.077	
Peripheral neuropathy	Post-test 3	4.031 (1.204)	2-6	5.343 (1.095)	3-7	0.867
	Normality (p-Value)		0.219		0.201	
Peripheral neuropathy	Post-test 4	2.968 (0.897)	2-5	4.812 (1.029)	3-7	0.628
	Normality (p-Value)		0.060		0.083	

Table 3 shows that the normality test using the Shapiro-Wilk normality test showed regularly distributed pre- and post-test glycemic control outcomes in the intervention and control groups with p-value>0.005. Lavene homogeneity test on glycemic control variables

pre-test with p-value 0.408 > 0.05, post-test 1 with 0.365 > 0.005, post-test 2 with 0.208 > 0.05, post-test 3 with 0.762 > 0.005, post-test 4 with 0.466 > 0.05 declares data homogeneous. Table 3 shows that the normality test using shapiro-wilk obtained normally distributed data on the results of pre-test to post-test 4 peripheral neuropathy in the intervention and control groups with a p-value > 0.05. Homogeneity test using Lavene statistic on peripheral neuropathy variables obtained pre-test results with a p-value of p-value 0.758 > 0.05, post-test 1 with a p-value of 0.616 > 0.05, post-test 2 with a p-value of 0.091> 0.05, post-test 3 with a p-value of 0.867 > 0.05, post-test 4 with a p-value of 0.628 > 0.05 so that the data is declared homogeneous.

Table 4. Analysis of Glycemic Control and Peripheral Neuropathy Before and After Diabetic Foot Spa Based on Orem's Theory (n=64)

Variables	Group	Mean±SD					Mean±SD Difference	p-Value
		Pre-test	Post-test 1	Post-test 2	Post-test 3	Post-test 4		
Glycemic Control	Intervention	145.0± 9.382	142.0± 9.278	138.3± 9.378	131.3± 7.622	124.0± 7.487	21.09±-1.895	0.000
	Control	145.0± 8.169	143.7± 7.946	141.0± 7.433	137.5± 7.678	133.2± 7.976	11.75±-4.087	0.000
Peripheral neuropathy	Intervention	6.781± 1.069	6.156± 1.080	5.125± 1.237	4.031± 1.204	2.968± 0.897	3.812± 1.119	0.000
	Control	6.593± 0.979	6.406± 0.910	5.968± 0.932	5.343± 1.095	4.812± 1.029	1.781± 0.792	0.000

Table 4 shows that the using paired t-tests were used in each intervention and control group, a p-value of <0.05 indicates a difference in glycemic management before and after diabetic foot spa (Table 5.4). The intervention group had a greater drop in glycemic control, averaging 21.09 mg/dl compared to 11.75 mg/dl in the control group. In the first week following the diabetic foot spa, blood sugar dropped significantly. Paired t-test analysis revealed a significant difference in peripheral neuropathy before and after diabetic foot spa in both intervention and control groups (p-value <0.05). The intervention group had a greater reduction in peripheral neuropathy (3.812) than the control group (1.781). In the first week following the diabetic foot spa, peripheral neuropathy decreased considerably.

Table 5. Analysis of Glycemic Control and Peripheral Neuropathy Effectiveness in Intervention and Control Groups (n=64).

Variables	Group	T-Test for Equality of Means			
		t	Mean Difference	Std Error Difference	p-value
Glycemic Control	Intervention Control	-5.096	-9.281	1.821	0.000
Peripheral neuropathy	Intervention Control	-7.635	-1.843	0.241	0.000

Table 5 shows that the effectiveness of diabetic foot spa in the intervention and control groups using the independent t-test, a p-value <0.05 was obtained, which states that diabetic foot spa is effective in reducing glycemic control in patients with type 2 DM. Table 5 shows that diabetic foot spa reduces peripheral neuropathy in type 2 DM patients, as shown by a p-value <0.05 in the independent t-test.

DISCUSSION

This study examined respondent characteristics, including age, gender, education, occupation, and duration of type 2 DM. Most respondents (53.1%) were aged 56–65, with older

adults more prone to DM due to decreased physical activity and insulin resistance (Nanayakkara et al., 2021; PERKENI, 2021; Rosita et al., 2022). Gender differences show men at risk due to visceral fat and unhealthy habits, while postmenopausal women face increased insulin resistance (Jena et al., 2022). Education influences DM management, with secondary education being most common (Mathisen et al., 2020). Most had DM for less than five years, though neuropathy risk increases with disease duration (Khawaja et al., 2018; Wu et al., 2021). Sedentary jobs heighten DM risk, while physically active work supports insulin sensitivity. High-stress jobs also contribute to poor glycemic control (Chowdhury et al., 2024).

Glycemic Control of Patients with Type 2 DM Before and After Receiving Orem's Theory-Based Diabetic Foot Spa in Treatment Group and Control Group. The study found that before the intervention, type 2 DM patients had poor glycemic control (>124 mg/dl). After a four-week diabetic foot spa intervention (20–25 minutes per session, three times per week), blood sugar levels significantly decreased, with greater improvement in the intervention group than in the control group, which only performed foot exercises. The effect became more evident after the first week as the body adapted (Silvia et al., 2021). This reduction is linked to metabolic regulation and insulin function (Alqahtani et al., 2020; Lee et al., 2022). The findings align with previous studies showing that regular diabetic foot spas improve glycemic control more effectively than foot exercises alone (Ainiyah & Wardani, 2021; Fiqriyah & Rosyid, 2024).

Peripheral Neuropathy Symptoms of Patients with Type 2 DM Before and After Receiving Orem's Theory-Based Diabetic Foot Spa in the Treatment Group and Control Group. The results showed before the diabetic foot spa intervention, type 2 DM patients experienced mild to severe peripheral neuropathy (score 4–8), with tingling and decreased foot sensitivity, especially at night due to poor blood flow and nerve inflammation (Castelli et al., 2020; Prahardini et al., 2024; Wu et al., 2021). After a four-week intervention (20–25 minutes, three times weekly), symptoms significantly improved, with a greater reduction in the intervention group (mean difference: 3.812) than the control group (1.781). This improvement is linked to better blood circulation, nerve function, and relaxation from warm water and gentle massage (Castelli et al., 2020; Ratnawati et al., 2020). VCO massage reduced ulcer risk, and saltwater soaking helped relieve pain and inflammation (Adevia et al., 2022; Vakilinia et al., 2020).

Effectiveness of Orem's Theory-based Diabetic Foot Spa on Peripheral Neuropathy Symptoms in Patients with Type 2 DM. Orem's theory-based diabetic foot spa effectively improves glycemic control and alleviates peripheral neuropathy symptoms in type 2 DM patients. The intervention, conducted over four weeks (20–25 minutes, three times weekly), enhances foot sensitivity and circulation through foot exercises, cleansing, and massage (Fauziyah et al., 2021; Vakilinia et al., 2020). Regular foot exercises improve nerve function and reduce neuropathy severity (Silvia et al., 2021). Orem's self-care theory highlights the importance of patient engagement in health maintenance, and diabetic foot spa encourages self-care and disease management (Takele et al., 2021). Improved circulation from foot exercises promotes vasodilation, enhancing nerve function and reducing neuropathy symptoms (Ainiyah et al., 2022; Gayatri et al., 2019; Indrayani & Diani, 2023). Warm saltwater soaking aids inflammation reduction and pain relief, while VCO massage prevents dryness and ulcers (Rukmana et al., 2019). This holistic approach not only relieves symptoms but also empowers patients to manage their condition, improving their quality of life.

Effectiveness of Orem's Theory-based Diabetic Foot Spa on Glycemic Control in Patients with Type 2 DM. A diabetic foot spa, based on Orem's self-care theory, is an effective non-pharmacological intervention for glycemic control and peripheral neuropathy management in type 2 DM patients. Studies show that diabetic foot exercises improve circulation and glucose metabolism by enhancing insulin receptor activation and glucose transport via GLUT-4 (Graciella & Prabawati, 2020; Silvia et al., 2021). Foot soaking in warm salt water promotes

vasodilation, enhancing blood flow by Vakilinia et al., (2020), while gentle foot massage stimulates glucose metabolism and insulin synthesis (Agustini & Dewi, 2017; Megayanti & Wulandari, 2021; Hendrawati et al., 2022). Orem's theory underscores the role of self-care in preventing complications, yet many type 2 DM patients lack adequate self-care practices, increasing the risk of foot amputations (Petersen et al., 2020). Implementing a supportive-educative system, where nurses guide and educate patients on diabetic foot spa, enhances self-care and glycemic control (Aliakbari et al., 2021; Bansal et al., 2023). Clinically, diabetic foot spa is a cost-effective therapy applicable in hospitals and clinics, reinforcing the importance of patient empowerment in diabetes management.

The current study has limitations, researchers cannot 100% control patients when fasting before fasting blood sugar checks, but researchers try to remind patients H-1 before fasting blood sugar checks. So in further research, it is hoped that HbA1c will be used in examining patient blood glucose so that the results are more valid. In this study, researchers did not assess the air temperature that could affect the results of measuring patient blood sugar levels, but researchers tried to do diabetic foot spas outside the room in both groups, so that in further research it is expected to measure air temperature in detail.

4. CONCLUSION

The diabetic foot spa intervention based on Orem's Theory decreased blood glucose levels by 21.09 mg/dl, compared to 11.75 mg/dl in the control group. A p-value <0.05 indicates a significant difference. After the diabetic foot spa intervention, peripheral neuropathy decreased more in the intervention group (3.812) than in the control group (1.781). A p-value <0.05 indicates a significant difference. An independent t-test shown that diabetic foot spa improved glycemic control and peripheral neuropathy in type 2 diabetes patients compared to the control group (p-value <0.05). Diabetic foot spa based on Orem's Theory is effective in improving glycemic control and reducing peripheral neuropathy symptoms in type 2 DM patients.

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