

EFFECTIVENESS OF COMBINING *LEMONGRASS ESSENTIAL OIL* AND FOOT EXERCISES USING MARBLES ON FOOT SENSITIVITY IN TYPE 2 DIABETES MELLITUS PATIENTS

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Abstract: Peripheral neuropathy is a condition experienced by patients with Type 2 Diabetes Mellitus, characterized by decreased nerve sensitivity, numbness, and loss of taste in the lower extremities. Foot care approaches such as foot exercises and the use of essential oils are considered effective alternatives to improve nerve sensitivity. This study aims to evaluate the effectiveness of Lemongrass Essential Oil (ESSOL) combined with foot exercises using marbles to increase foot sensitivity in Type 2 diabetic patients. This research employs a quantitative study with a quasi-experimental approach using a pre-test-post-test design with a control group. The sample was taken based on the inclusion and exclusion criteria, totaling 40 respondents. The sample was divided into two groups: an intervention group and a control group. Feet sensitivity was measured using a monofilament test before and after intervention. The results show a significant increase in foot sensitivity values in the intervention group compared to the control group. Statistical analysis shows a p-value < 0.05, which indicates that the combination of ESSOL therapy and gymnastic media foot marbles was effective in increasing the sensitivity of type 2 diabetic patients. This combination has proven effective as a non-pharmacological intervention to enhance the sensitivity of type 2 diabetic patients.

Keywords: foot care; lemongrass essential oil; monofilament

1. Introduction

Type 2 Diabetes Mellitus (T2DM) is a chronic disease characterized by insulin resistance and pancreatic beta cell dysfunction, causing hyperglycemia and peripheral nerve complications(1) . The global prevalence of T2DM is estimated to reach 537 million adults, with predictions of an increase to 783 million by 2045, while Indonesia ranks fifth in the world with 19.5 million sufferers, and this figure is estimated to increase to 28.6 million people(2) . Peripheral neuropathy is a common chronic complication of T2DM and is a major risk factor for diabetic wounds(3) . Approximately 37.5% of people with DMT2 experience decreased foot sensitivity, which can be prevented through foot care programs(4) ;(5) .

Non-pharmacological therapies, including marble ball foot exercises and essential oil application, are effective alternatives for preventing the progression of neuropathy(6) . Marble foot exercises provide mechanical stimulation to the soles of the feet, improving blood circulation, neuroplasticity, and intrinsic muscle strength, thereby increasing foot sensitivity(7) ;(8) . Lemongrass essential oil (ESSOL) contains active compounds such as citral and geraniol, which have anti-inflammatory and neuroprotective properties, supporting nerve regeneration and improving foot sensitivity in patients with DMT2(9) .

Although previous studies have shown that ESSOL improves Ankle Brachial Index (ABI) values(10) , and marble foot exercises improve foot sensitivity(11) , the effectiveness of combining these two therapies is still limited and controversial, especially in local contexts with high prevalence such as Aceh. Several studies have shown that the effects of non-pharmacological therapies are short-term or insignificant in certain populations, thus requiring further evaluation.

Based on this research gap, this study aims to evaluate the effectiveness of the combination of ESSOL and marble foot exercises on foot sensitivity in DMT2 patients in the

working area of the Ulee Kareng Community Health Center, Banda Aceh City. This study is expected to provide scientific evidence regarding a simple, economical, and self-administered non-pharmacological intervention for DMT2 patients to prevent neuropathy complications.

2. Literature Review

2.1 Diabetes Mellitus

The WHO explains that diabetes mellitus is a group of metabolic disorders characterized by elevated blood sugar levels (hyperglycemia). This is caused by the effects of insulin and insulin performance. Diabetes mellitus has long-term effects such as neuropathy, retinopathy, and other complications. Complications of diabetes include an increased risk of heart disease, peripheral artery disease, obesity, cataracts, fatty liver disease, and even infectious diseases such as tuberculosis(12,13) . This disease has long-term complications, including neuropathy, retinopathy, cardiovascular disease, peripheral artery disease, obesity, cataracts, fatty liver disease, and an increased risk of infections such as tuberculosis(2) . The International Diabetes Federation (IDF) emphasizes that DM is a life-threatening non-communicable disease and is called a "silent killer" because of its gradual but continuous development of complications, reducing the life expectancy of sufferers(3) .

DM is classified into several types based on etiology, namely Type 1 (DMT1) due to autoimmunity that damages pancreatic beta cells, requiring patients to take insulin; DMT2) is a chronic metabolic disorder characterized by hyperglycemia due to a combination of insulin resistance and secondary insulin deficiency, often associated with obesity, unhealthy lifestyles, and genetic factors(1) . In T1D, the pancreas is still able to produce insulin, but its use by the body's cells is ineffective, so blood glucose levels remain high. This condition causes various long-term complications, including peripheral neuropathy, retinopathy, cardiovascular disease, and the risk of diabetic wounds, which significantly affect the quality of life of sufferers(14) .

2.2 Foot Care

Foot care for people with diabetes mellitus is an important step in preventing long-term complications, especially diabetic ulcers, which can lead to serious infections and amputations(15) . Peripheral neuropathy and circulatory disorders are the main factors that increase the susceptibility of the feet to injury and infection. Preventive measures include education on foot care, identification of risk factors, blood glucose management, selection of appropriate footwear, and early treatment of wounds or abnormalities on the feet. Systematic clinical examinations include dermatological, vascular, neurological, and musculoskeletal evaluations, using tools such as the Ankle Brachial Index (ABI), Semmes-Weinstein monofilament, tuning fork, needle prick test, and Achilles reflex, to detect changes in nerve function and blood flow.

Proper foot care includes cleanliness, moisture, daily checks, nail trimming, and choosing shoes and socks that support comfort and good pressure distribution. Washing your feet with warm water and mild soap, using moisturizer appropriately, and avoiding the use of sharp objects or harsh antiseptics on wounds are important preventive measures. Choosing the right footwear, with soft soles and good ventilation, including orthopedic shoes for patients with foot deformities, has been proven effective in reducing the risk of wounds and long-term complications(16)

2.3 Foot Sensitivity

Foot sensitivity is the body's ability to respond to stimuli provided by external actions through the nervous system. In the human foot, this explains why the foot responds to touch, pressure,

heat or cold, and pain. Organ coordination to assess the level of sensitivity in the body is important for self-protection, coordination, and protection from things that can cause injury(17) .

2.4 Monofilament SW 10 g

SWMT 5.07/10 g is the most commonly used type of monofilament for testing light pressure or touch sensations. This test should be performed at ten different points on each foot, namely: the distal part of the first toe, the distal part of the third toe, the distal part of the fifth toe, the first plantar metatarsal head, the third plantar metatarsal head, the fifth plantar metatarsal head, the medial and lateral plantar arches, the plantar heel, and the first dorsal space. The monofilament test is indicated for patients with DMT2 who experience neuropathy symptoms (decreased foot sensitivity). The use of the monofilament test in the detection of neuropathy is highly recommended because patients can personally assess the progression of their disease. This reduces the risk of serious infections in the feet of DMT2 patients(18) .

2.5 Lemongrass Essential Oil

Lemongrass essential oil (serih oil), extracted from the stems and leaves of *Cymbopogon* spp., is an essential oil widely used in non-pharmacological therapies as well as cosmetic and topical health products(10) . This oil contains key active compounds, including citral (geranial and neral), geraniol, citronellal, and citronellol, which have antimicrobial, anti-inflammatory, antioxidant, and antifungal effects, providing a wide range of therapeutic benefits. In addition, lemongrass essential oil has calming properties that can stimulate relaxation, reduce stress and anxiety, and play a role in treating skin inflammation and infections, both in traditional and modern medicine(19) .

2.6 Medium Marble Foot Exercise

This diabetes foot exercise has benefits for improving blood flow to the feet, strengthening the small muscle structures in the feet, preventing changes in the shape of the feet, training the calf and thigh muscles, and overcoming various joint problems. Improved blood flow is the primary goal of this exercise for patients with type 2 diabetes (DMT2). Enhanced blood supply to the feet reduces the risk of neuropathy, which increases foot sensitivity in DMT2 patients who have experienced numbness in their feet. The marble-based foot exercise is relatively easy to perform, making it simpler for DMT2 patients to manage their condition(20) .

3. Method

This study is qualitative in nature with a quasi-experimental approach. The design used is *a pre-test post-test with control group* design to assess the effectiveness of the combination of lemongrass essential oil (ESSOL) and marble foot exercises on the sensitivity of the feet of patients with type 2 diabetes mellitus (DMT2). The study population consisted of 223 T2DM patients in the working area of the Ulee Kareng Community Health Center, with a sample of 40 respondents selected purposively and divided into intervention and control groups. The instrument used was a 10 g Semmes-Weinstein monofilament to measure foot sensitivity. In addition, the lemongrass essential oil (ESSOL) used was a pure extract, while marbles were prepared as a means of foot exercise. The research procedure was carried out in several stages. In the initial stage, the researchers made preparations, including coordinating with the health center, recruiting respondents, and conducting a pre-test to measure foot sensitivity using monofilament. Next, the intervention group was given combination therapy in the form of massage with ESSOL on the foot area, followed by foot exercises using marbles, while the control group only received standard care according to the health center protocol. The intervention was carried out routinely according to a predetermined schedule, with the

researcher present to ensure the respondents' compliance with the procedure. After the intervention period ended, a post-test was conducted again to measure foot sensitivity in both groups. The analysis began with a normality test to determine the data distribution, followed by a paired t-test to see the changes in sensitivity before and after the intervention in the same group, and an independent sample t-test to compare the differences in results between the intervention and control groups. The significance level was set at $p < 0.05$.

4. Findings and Discussion

4.1 Demographic Data

Table 1. Frequency Distribution of Type 2 DM Patient Intervention Groups at the Ulee Kareng Community Health Center in Banda Aceh City

No	Category	Type	Frequency	Percentage
1.	Gender	Male	5	66.7
		Female	15	33.3
2.	Age	20 years	-	-
		30 years	1	5.0
		40 years	3	15.0
		50	9	45.0
		60 years	7	35.0
3.	Education	Elementary	2	6.7
		Junior High School	1	3.3
		High School	13	43.3
		Higher Education	4	13.3
4	Employment	Not working	6	20.0
		Civil servant	3	10.0
		Self-employed	3	10.0
		Farmer	3	10.0
		Retired	-	-
		Other	5	16.7
5.	Diabetic Ulcer	Yes	-	-
		None	20	66.7
6.	Treatment	Oral	19	63.3
		Insulin	-	-
		Oral & Insulin	1	3.3
7.	Blood Sugar Test	1 Month	19	63.3
		3 Months	-	-
		6 Months	1	3.3
8.	Duration of DM	Under 2 years	13	43.3
		Over 2 years	7	23.3
Total				100

Table 2. Frequency Distribution of the Control Group of Type 2 DM Patients at the Ulee Kareng Community Health Center in Banda Aceh City

No	Category	Type	Frequency	Percentage
1.	Gender	Male	4	20.0
		Female	16	80
2.	Age	20 years	-	-
		30 years	1	5.0
		40 years	6	30.0
		50	11	55.0
		60 years	2	10.0
3.	Education	Elementary	1	5.0
		Junior High School	-	-
		High School	15	75.0

		Higher Education	4	20.0
4.	Employment	Not working	9	45.0
		Civil servant	3	15.0
		Self-employed	3	15.0
		Farmer	-	-
		Retired	-	-
		Other	5	25.0
5.	Diabetic Ulcer	Yes	-	-
		None	20	100.0
6.	Treatment	Oral	19	95.0
		Insulin	-	-
		Oral & Insulin	1	5.0
7.	Blood Sugar Test	1 Month	20	100.0
		3 Months	-	-
		6 Months	-	-
8.	Duration of DM	Less than 2 years	11	55.0
		Over 2 years	9	45.0
	Total			100.0

4.2 Univariate Analysis

Table 3. Distribution of Foot Sensitivity Scores in the Intervention Group

Pre-Test		
Category	Frequency	
	Left	Right
Low (0-3)	5	6
Moderate (4-6)	13	10
Sufficient (7-8)	1	3
Good (9)	0	0
Total	20	20

Post-Test		
Category	Frequency	
	Left	Right
Low (0-3)	0	0
Moderate (4-6)	6	6
Sufficient (7-8)	10	11
Good (9)	4	3
Total	20	20

Table 4. Distribution of Foot Sensitivity Scores in the Control Group

Pre-Test		
Category	Frequency	
	Left	Right
Low (0-3)	2	2
Moderate (4-6)	10	11
Sufficient (7-8)	8	7

Good (9)	0	0
Total	20	20

Post-Test		
Category	Frequency	
	Left	Right
Low (0-3)	1	2
Moderate (4-6)	9	10
Sufficient (7-8)	9	8
Good (9)	1	0
Total	20	20

4.3 Bivariate Analysis Data

Table 5. Shapiro-Wilk Normality Test for the Intervention Group and Control Group

Variable		Shapiro-Wilk		
		Statisti	df	Sig.
		c		
Intervention	Left <i>Pre-Test</i>	.910	.20	.064
	Left <i>Post-Test</i>	.922	.20	.107
	Right <i>Pre-Test</i>	.963	.20	.605
	Right <i>Post-Test</i>	.922	.20	.107
Control	Left <i>Pre-Test</i>	.926	.20	.128
	Left <i>Post-Test</i>	.951	.20	.382
	Right <i>Pre-Test</i>	.940	.20	.241
	Right <i>Post-Test</i>	.925	.20	.209

Table 6. Paired Sample T-Test Pretest-Posttest Intervention Group and Control Group

		Mean	Std. Deviation	Sig. (2-tailed)
Intervention	Left	-2.650	1,954	,000
	Right	-2,900	1,252	,000
Control	Left	-,200	,523	,104
	Right	-,100	,308	.163

Table 7. Independent T-Test for Comparison of Intervention Group and Control Groups

	t	df	Sig.	Mean Difference
Left	-2.569	38	.014	-1.150
Right	-3,024	38	,004	-1,350

The intervention group that received a combination of lemongrass essential oil (ESSOL) therapy and marble ball foot exercises showed a significant increase in foot sensitivity ($p < 0.05$), indicating the effectiveness of the intervention in stimulating peripheral nerve function that had been impaired due to diabetic neuropathy. Conceptually, ESSOL, with its citral and geraniol content, acts as an anti-inflammatory, antioxidant, and neuroprotective agent, while marble foot exercises improve coordination, blood circulation, and stimulate peripheral nerves, so that the two complement each other in improving nerve regeneration and foot sensitivity. These results are in line with the research by Vonna et al. (2023), which proved that ESSOL is effective in increasing the ABI of DMT2 patients, and Fadhillah et al. (2022), which stated that marble foot exercises improve foot sensitivity. However, this study is superior because it combines both methods with a holistic approach. The researchers argue that this intervention is particularly relevant for elderly patients with a long history of DMT2 and low physical activity, as it has been proven to overcome biological limitations and serves as a practical, non-pharmacological alternative that can be easily implemented at home to improve the quality of foot care for DMT2 patients.

The control group that did not receive the combination of ESSOL therapy and marble foot exercises showed no significant improvement in foot sensitivity ($p > 0.05$), so the condition remained stagnant and had the potential to worsen due to the progression of diabetic neuropathy. Conceptually, peripheral neuropathy in DMT2 is a chronic complication that requires active stimulation through non-pharmacological therapy to promote nerve regeneration and improve blood circulation, which did not occur in this group due to the absence of intervention. These findings are in line with studies by Nur et al. (2021), Triani et al. (2022), and Paju et al. (2022), which reported that groups without foot exercises or massage did not experience significant changes in sensory function. The majority of respondents in the control group were elderly with a history of DMT2 of more than 5 years and a less active lifestyle, conditions that theoretically increase the risk of progressive neuropathy (Aulia, 2023). The researchers argue that these results emphasize the importance of targeted interventions such as ESSOL and marble-based foot exercises, as without active stimulation, the sensitivity of the feet of DMT2 patients will not improve and may even deteriorate as the disease progresses.

The combination of ESSOL, which has anti-inflammatory and neuroprotective properties, with marble-based foot exercises that strengthen muscles and improve blood flow works synergistically to improve peripheral nerve sensitivity, in line with Orem's self-care principle that patients need assistance in addressing self-care deficits. These findings are consistent with the studies by Vonna et al. (2023) and Putri (2024), which each demonstrated the benefits of ESSOL and foot exercises independently, but this study is stronger because it shows the effectiveness of the combination of both compared to the control group. The researchers assessed that the significant difference was not influenced by the characteristics of the respondents—which were similar in both groups—but purely by the effect of the intervention, thus proving that this simple, safe, and easy-to-apply therapy can be an effective promotive and preventive strategy in the management of diabetic neuropathy, especially in DMT2 patients who are elderly, have a long duration of illness, and have a less active lifestyle.

5. Conclusion and Recommendation

In the intervention group, there was an effective combination of lemongrass *essential oil* and foot exercises using marbles to improve foot sensitivity. This was evidenced by a p-value of 0.000 in both the left and right feet, indicating that the therapy was effective in improving foot sensitivity in patients with type 2 diabetes mellitus. In the control group, there was no significant effectiveness in foot sensitivity, with a p-value of 0.104 for the left foot and $p = 0.163$ for the right foot. This indicates that without the combination of ESSOL and foot exercises, there was no significant change in the patients' foot sensitivity. There was a difference in effectiveness between the intervention group and the control group after treatment. With a p-value of 0.014 for the left foot and $p = 0.004$ for the right foot. This indicates that the combination of ESSOL and marble foot exercises is more effective than no intervention in improving foot sensitivity in patients with type 2 diabetes mellitus.

The results of this study have important implications for various parties. Health workers, especially nurses and physiotherapists, are expected to apply a combination of lemongrass essential oil therapy and marble foot exercises as an independent intervention and education for diabetic patients with foot sensitivity disorders. Diabetes mellitus patients are also advised to routinely perform foot exercises and use lemongrass essential oil as part of self-care at home to improve sensitivity and prevent further neuropathy complications. In addition, community health centers and health institutions are expected to integrate this therapy into chronic disease management programs through patient education and training. For further research, it is recommended that interventions be conducted over a longer duration, with a larger sample size, and taking into account factors such as age, duration of diabetes, and body mass index to obtain more comprehensive results.

Reference

1. Delfina S, Carolita I, Habsah S, Ayatillahi S. Analysis of risk factors for type 2 diabetes mellitus in productive age. *Tambusai Health Journal*. 2021;2(4):141–51.
2. Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, et al. IDF Diabetes Atlas: Global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. *Diabetes research and clinical practice*. 2022;183:109119.
3. Karout S, Soubra L, Rahme D, Karout L, Khojah HMJ, Itani R. Prevalence, risk factors, and management practices of primary dysmenorrhea among young females. *BMC Women's Health*. 2021 Nov 8;21(1):392.
4. Rahayu CE, Putri S. The Effect of Diabetes Self Management Education (DSME) on the Prevention of Diabetic Foot. *Jurnal Kesehatan STIKes Sumber Waras*. 2022;4(1):9–18.
5. Owolabi LF, Alghamdi M, Adamu B, Taura MG, Jibo A, Almansour M, et al. Magnitude of diabetic peripheral neuropathy in Saudi Arabia: a systematic review and meta-analysis. *BMC Endocr Disord*. 2022 Nov 2;22(1):266.
6. Sukron S, Efraliza E. The effect of diabetic foot exercises on the sensitivity level of the feet of type 2 diabetes mellitus clients. *Jurnal' Aisyiyah Medika [Internet]*. 2021 [cited 2025 Aug 30];6(1).
7. Sumarni T, Hartanto YD. Foot Exercises for the Prevention and Treatment of Diabetic Peripheral Neuropathy in People with Diabetes Mellitus. *Jurnal Pengabdian Masyarakat-Pimas*. 2023;2(2):111–8.

8. Ariyanti N. Foot Exercises Affect Foot Sensitivity in People with Type 2 Diabetes Mellitus [Internet] [PhD Thesis]. Yogyakarta Ministry of Health Polytechnic; 2021 [cited 2025 Aug 11].
9. Ahmad AR, Amaliah A, Abidin Z, Razak R, Malik A. Development of Natural Medicines (Essential Oils) [Internet]. Nas Media Pustaka; 2024 [cited 2025 Aug 30].
10. Vonna RD, Arista T, Salsabila N, Tharida M, Mulfianda R. Effectiveness of Lemongrass Essential Oil (ESSOL) on Ankle Brachial Index (ABI) Values in Type 2 Diabetes Mellitus Patients. In: Proceedings of SEMDI-UNAYA (UNAYA National Multidisciplinary Seminar) [Internet]. 2023 [cited 2025 Aug 30]. p. 295–306.
11. Putri AB. The Effect of Foot Exercises Using Marbles on Foot Sensitivity in Type II Diabetes Mellitus Patients in Keboan Anom Village, Gedangan District, Sidoarjo Regency [Internet] [PhD Thesis]. Bina Sehat PPNI University Library; 2024 [cited 2025 Aug 31].
12. Diabetes [Internet]. [cited 2024 Dec 11]. Available from: <https://www.who.int/health-topics/diabetes>
13. Sriyati S. Diabetic Neuropathy as a Predisposing Factor for Foot Ulcers. *Stikers Yarsi Mataram Scientific Journal*. 2024;
14. Sari LA, Dasuki D. Knowledge of Foot Care in Patients with Diabetes Mellitus. *Journal of Health Sciences*. 2024;10(2):17–23.
15. Edmonds M, Manu C, Vas P. The current burden of diabetic foot disease. *Journal of Clinical Orthopaedics and Trauma*. 2021;17:88–93.
16. Sukron S, Efraliza E. The effect of diabetic foot exercises on the level of foot sensitivity in type 2 diabetes mellitus clients. *Jurnal'Aisyiyah Medika* [Internet]. 2021 [cited 2024 Dec 11];6(1). Available from
17. Parliani N, Kep M, Ramadhaniyati N, Kep M, Kep S. Instruments and Guidelines for Foot Care of Diabetes Mellitus Patients in Home Care Settings [Internet]. CV Jejak (Jejak Publisher); 2021 [cited 2024 Dec 12]. Available from:
18. Wisdawati W, Razak R. Wound Healing Herbal Formulation from Essential Oil of Lemongrass (*Cymbopogon citratus*). *Indonesian Journal of Pharmaceutical and Clinical Research*. 2024;7(1):1–6.
19. Wahyuni A, Oktorina R. Comparison of Foot Sensitivity Between Foot Exercises Using Newspapers and Marbles in Type II Diabetes Mellitus Patients. *Jurnal Endurance*. 2021;6(2):385–92.