

EFFECTIVENESS OF BUEGER ALLEN EXERCISE ON PROTECTIVE FOOT SENSATION AMONG PATIENTS WITH TYPE 2 DIABETES MELLITUS

Muchamad Yafi' Aditiya Fawwaz, Enny Virda Yuniarti, Raras Merbawani

Bina Sehat PPNI University, Mojokerto, Indonesia

Corresponding Author: yafik.adty@gmail.com

ABSTRACT

Diabetic peripheral neuropathy is a common complication of type 2 diabetes mellitus that increases the risk of foot ulceration due to impaired protective sensation. This study evaluated the effect of Buerger Allen Exercise (BAE) on protective foot sensation among patients with type 2 diabetes mellitus. A pre-experimental one-group pretest–posttest design was conducted among 31 patients selected through purposive sampling. Protective foot sensation was assessed using the Semmes–Weinstein 10 g monofilament test before and after BAE performed once daily for three consecutive days. Data were analyzed using the Wilcoxon Signed Rank Test. The mean monofilament score increased from 2,68 and 2,58 to 7,52 and 7,39 in both feet, with a significant improvement after the intervention ($p = 0.000$). Buerger Allen Exercise effectively improved protective foot sensation and may serve as a simple, safe, and low-cost nursing intervention for preventing diabetic foot complications in primary healthcare settings.

Keywords: *BAE; type 2 diabetes mellitus; protective foot sensation; 10g monofilament test.*

INTRODUCTION

Type 2 diabetes mellitus (T2DM) remains one of the most prevalent chronic diseases worldwide and continues to increase each year, posing a major public health challenge. Persistent hyperglycemia contributes to various microvascular complications, particularly diabetic peripheral neuropathy, which reduces quality of life and increases the risk of foot ulceration, infection, and lower-extremity amputation (Mawaddah, 2024). Hyperglycemia-induced microvascular dysfunction impairs peripheral nerve perfusion, leading to progressive nerve ischemia, disrupted nerve impulse transmission, and gradual loss of protective foot sensation manifested by numbness, tingling, and burning sensations (Suratun et al., 2025).

According to the World Health Organization, more than 420 million people were living with diabetes in 2023, and the global burden is projected to reach approximately 700 million by 2045 (Zaki et al., 2024). Previous studies have reported that the prevalence of diabetic peripheral neuropathy ranges from 6% to 51% worldwide (Harli et al., 2023). In Indonesia, diabetes affects approximately 19.47 million adults, with diabetic neuropathy occurring in nearly 43.9% of patients, highlighting the importance of early detection and effective interventions to preserve peripheral nerve function (Wulandari et al., 2023).

Maintaining peripheral circulation through regular physical exercise is recommended as part of comprehensive diabetes management (Suryati et al., 2020). Buerger Allen Exercise (BAE), which combines postural changes with active ankle movements, has been shown to improve lower-extremity blood flow through activation of the muscle pump mechanism, thereby enhancing tissue perfusion and peripheral nerve function (Rahmi & Rasyid, 2023). Previous studies consistently demonstrated that BAE improves foot sensitivity and peripheral circulation in patients with diabetes mellitus (Firdaus et al., 2024).

Despite these promising findings, evidence regarding the effectiveness of Buerger Allen Exercise on protective foot sensation assessed using the standardized Semmes–Weinstein 10 g Monofilament Test in primary healthcare settings remains limited. Furthermore, variations in intervention protocols and outcome measurements across previous studies limit the generalizability of existing evidence. Therefore, further investigation is needed to strengthen evidence supporting the implementation of Buerger Allen Exercise as a simple and feasible nursing intervention in community-based diabetes care.

This study aimed to evaluate the effect of Buerger Allen Exercise on foot sensitivity measured using the Semmes–Weinstein 10 g Monofilament Test among patients with type 2 diabetes mellitus at UPTD Puskesmas Dlanggu, Mojokerto Regency. The findings are expected to provide evidence supporting the integration of Buerger Allen Exercise into routine nursing practice to improve protective foot sensation and reduce the risk of diabetic foot complications in primary healthcare settings.

METHOD

This study employed a pre-experimental design with a one-group pretest–posttest approach to evaluate the effect of Buerger Allen Exercise (BAE) on protective foot sensation among patients with type 2 diabetes mellitus (T2DM). The study was conducted from 17 to 23 April 2026 at UPTD Puskesmas Dlanggu, Mojokerto Regency, East Java, Indonesia. The study population consisted of 51 patients with T2DM who were actively enrolled in the Chronic Disease Management Program (Prolanis). Participants were recruited using purposive sampling based on predefined inclusion and exclusion criteria, resulting in a final sample of 31 participants.

Baseline protective foot sensation was assessed using the standardized Semmes–Weinstein 10 g Monofilament Test before the intervention. Subsequently, participants performed Buerger Allen Exercise according to the standardized operating procedure. The intervention consisted of lower-limb elevation, dependent positioning, and active ankle dorsiflexion and plantarflexion movements. Each session lasted approximately 15–20 minutes and was performed once daily for three consecutive days. Protective foot sensation was reassessed after completion of the intervention using the same standardized monofilament examination.

Data were analyzed using IBM SPSS Statistics. Descriptive statistics were used to summarize participants' demographic and clinical characteristics. Data normality was assessed using the Shapiro–Wilk test. Since the pretest and posttest scores were not normally distributed, differences in protective foot sensation before and after the intervention were analyzed using the Wilcoxon signed-rank test. Statistical significance was established at a two-tailed p -value of <0.05 .

FINDING AND DISCUSSION

RESEARCH RESULT

Table 1 Age characteristics

Variabel	N	Mean	Median	Standar Deviasi	Min-Max
Usia	31	55.94	54.00	7.155	46-72

A total of 31 participants were included in this study. The mean age of the participants was 56 years, with a median age of 54.00 years. Participants ranged in age from 46 to 72 years, indicating that the study population predominantly consisted of middle-aged and older adults.

Table 2 Respondent characteristics

Karakteristik Responden	Frekuensi (f)	Persentase (%)
Jenis kelamin		
Laki-laki	3	9,7
Perempuan	28	90,3
Total	31	100
Lama menderita DM		
≤5	24	77,4
>5	7	22,6
Total	31	100
Riwayat merokok		
≤5 batang/hari	1	3,2
Tidak merokok	30	96,8
Total	31	100
Keluhan		
Kesemutan	16	51,6
Kebas	11	35,5
Nyeri terbakar	4	12,9
Total	31	100
Penyakit penyerta		
Hipertensi	19	61,3
Jantung	1	3,2
Lain-lain	11	35,5
Total	31	100

The characteristics of the participants are presented in Table 2. Most participants were female, accounting for 28 participants (90.3%). Most participants had been diagnosed with type 2 diabetes mellitus for ≤5 years, comprising 24 participants (77.4%). The majority did not smoke 30 participants (96.8%). Tingling was the most frequently reported complaint 16 participants (51.6%), while hypertension was the most common comorbidity 19 participants (61.3%).

Table 3 Foot sensitivity before BAE

	Mean	Min-Max	Std. Deviation
Pre-Test Kaki Kanan	2.68	1-5	.979
Pre-Test Kaki Kiri	2.58	1-4	.886

Before the intervention, participants generally demonstrated decreased protective foot sensation in both feet. The mean protective foot sensation score was 2.68 for the right foot and 2.58 for the left foot, indicating impaired peripheral sensory function prior to the implementation of Buerger Allen Exercise.

Table 4 Foot sensitivity after BAE

	Mean	Min-Max	Std. Deviation
Post-Test Kaki Kanan	7.52	5-9	.996
Post-Test Kaki Kiri	7.39	6-9	.844

Following three consecutive days of Buerger Allen Exercise, protective foot sensation improved in both feet. The mean score increased to 7.52 in the right foot and 7.39 in the left foot after completion of the intervention.

Table 5. Difference in mean left and right foot sensitivity before and after BuergerAllen exercises in patients with Type II Diabetes Mellitus

Sensitivitas kaki	Mean	Selisih	Min-Max	Std. Deviation	Std. Error	p-value
Pre-Test Kaki Kanan	2.68	4.84	1-5	.979	.176	0.000
Post-Test Kaki Kanan	7.52		5-9	.996	.179	

The Wilcoxon signed-rank test demonstrated statistically significant differences in protective foot sensation before and after the intervention for both feet. Significant improvements were observed in the right and left feet ($p < 0.001$).

DISCUSSION

The present study demonstrated that Buerger Allen Exercise (BAE) significantly improved protective foot sensation in patients with type 2 diabetes mellitus. The Wilcoxon Signed Rank Test showed a statistically significant difference between pre- and post-intervention measurements in both feet ($p = 0.000$), with the mean monofilament score increasing from 2.68 to 7.52 in the right foot and from 2.58 to 7.39 in the left foot after three consecutive days of intervention. These findings indicate that BAE effectively restores protective foot sensation, which is an important clinical indicator for reducing the risk of diabetic foot ulceration and lower-extremity amputation in patients with diabetic peripheral neuropathy (Pop-busui et al., 2017). The present findings are consistent with previous studies reporting significant improvements in foot sensitivity and peripheral circulation following Buerger Allen Exercise among patients with diabetes mellitus (Mukaromah et al., 2026). Collectively, these studies suggest that BAE provides measurable benefits in improving peripheral sensory function and may serve as an effective complementary nursing intervention for preventing diabetic foot complications in primary healthcare settings. The

observed improvement may be attributed to the combination of postural changes and active ankle movements during BAE, which enhance peripheral blood flow, increase oxygen and nutrient delivery to peripheral nerves, and support the recovery of sensory nerve function (Wijayanti & Warsono, 2022).

The improvement in protective foot sensation observed after Buerger Allen Exercise is closely related to its physiological effects on peripheral circulation. Chronic hyperglycemia in type 2 diabetes mellitus induces endothelial dysfunction, microvascular impairment, and reduced tissue perfusion, which gradually compromise peripheral nerve metabolism and contribute to diabetic peripheral neuropathy (Hall & Hall, 2021). Buerger Allen Exercise combines lower-limb elevation, dependent positioning, and repetitive dorsiflexion–plantarflexion movements that stimulate the calf muscle pump, enhance venous return, and improve arterial perfusion to the lower extremities (Rahmi & Rasyid, 2023). Improved blood flow increases oxygen and nutrient delivery to peripheral nerves, facilitating nerve metabolism and recovery of protective sensation, which may explain the significant increase in monofilament scores observed in the present study. Similar physiological responses have been reported by (Harli et al., 2023) and (Firdaus et al., 2024), who found that enhanced peripheral circulation following Buerger Allen Exercise was associated with improved sensory function among patients with diabetes mellitus. Likewise, (Novitasari et al., 2024) and (Mukaromah et al., 2026) demonstrated that regular implementation of Buerger Allen Exercise contributed to better lower-extremity perfusion and neurological function, supporting its role as an evidence-based intervention for preventing diabetic foot complications.

The findings of the present study further strengthen the existing evidence regarding the effectiveness of Buerger Allen Exercise in improving protective foot sensation among patients with type 2 diabetes mellitus. The significant increase in monofilament scores observed after three consecutive days of intervention is consistent with previous studies reporting improvements in foot sensitivity, peripheral circulation, and lower-extremity vascular status following Buerger Allen Exercise (Suryati et al., 2019). Although variations in intervention duration, exercise frequency, sample characteristics, and outcome measures were reported across these studies, the direction of the findings consistently indicates that Buerger Allen Exercise contributes to improved lower-extremity sensory function. One possible explanation is that participants in the present study were routinely monitored during the intervention period, ensuring that each exercise session was performed according to the standardized protocol. Furthermore, the use of the Semmes–Weinstein 10 g monofilament test, a widely recommended tool for assessing protective foot sensation in patients with diabetes mellitus, provides an objective evaluation of neurological function and strengthens the clinical relevance of the findings (Smeltzer et al., 2010). Therefore, the present study not only confirms previous evidence but also supports the application of Buerger Allen Exercise in primary healthcare settings using standardized neurological assessment.

The findings of this study have important implications for nursing practice, particularly in primary healthcare settings where early prevention of diabetic foot complications is a priority. Considering that Buerger Allen Exercise is simple, safe, inexpensive, and does not require specialized equipment, nurses can easily incorporate this intervention into routine diabetes management and patient education programs (Rahmi & Rasyid, 2023). In addition to regular screening using the Semmes–Weinstein 10 g

monofilament test, nurses should encourage patients to perform Buerger Allen Exercise consistently as part of diabetes self-management to maintain peripheral circulation and preserve protective foot sensation (Pop-busui et al., 2017). Previous studies have demonstrated that routine implementation of Buerger Allen Exercise not only improves lower-extremity circulation but also contributes to better sensory function and reduces the risk of diabetic foot complications (Firdaus et al., 2024). Therefore, integrating Buerger Allen Exercise into evidence-based nursing care may enhance patients' quality of life, reduce disability associated with diabetic peripheral neuropathy, and potentially decrease the healthcare burden related to diabetic foot ulceration and lower-extremity amputation.

Despite the promising findings, several limitations should be considered when interpreting the results of this study. The use of a one-group pretest–posttest design without a control group limits the ability to attribute the observed improvement exclusively to Buerger Allen Exercise. In addition, the relatively small sample size and recruitment from a single primary healthcare center may restrict the generalizability of the findings to broader populations with different demographic and clinical characteristics (Chang et al., 2016). Furthermore, the intervention was conducted over only three consecutive days; therefore, the long-term effects of Buerger Allen Exercise on protective foot sensation remain uncertain. Future studies are recommended to employ randomized controlled trial designs, larger and more diverse samples, longer intervention periods, and follow-up assessments to evaluate the sustainability of treatment effects. Combining Buerger Allen Exercise with other evidence-based nursing interventions may also provide a more comprehensive strategy for preventing diabetic peripheral neuropathy and diabetic foot complications (Pop-busui et al., 2017). Nevertheless, the present study adds to the growing body of evidence supporting Buerger Allen Exercise as a practical, safe, and cost-effective nursing intervention for improving protective foot sensation among patients with type 2 diabetes mellitus in primary healthcare settings.

CONCLUSION

This study demonstrated that Buerger Allen Exercise significantly improved protective foot sensation in patients with type 2 diabetes mellitus, indicating its effectiveness as a non-pharmacological nursing intervention for individuals with impaired peripheral sensory function. The improvement in protective sensation suggests that Buerger Allen Exercise enhances peripheral circulation, thereby supporting sensory nerve function and reducing the risk of diabetic foot complications. Given that the intervention is simple, safe, inexpensive, and can be performed independently, it has the potential to be integrated into routine nursing care and diabetes self-management programs, particularly in primary healthcare settings. Incorporating Buerger Allen Exercise into comprehensive diabetes management may contribute to the early prevention of diabetic peripheral neuropathy and diabetic foot ulcers while improving patients' quality of life. Further studies using randomized controlled designs, larger sample sizes, and longer intervention periods are recommended to strengthen the evidence regarding the long-term effectiveness of this intervention.

REFERENCES

- Chang, C., Chen, M., Shen, J., Lin, Y. Bin, Hsu, W., & Lin, B. (2016). *A quantitative real-time assessment of Buerger exercise on dorsal foot peripheral skin circulation in patients with diabetes foot*. 1–5.
- Firdaus, I., Novitasari, H., & Widiastuti, A. (2024). *Efektivitas Penerapan Buerger Allen Exercise Terhadap Sensitivitas Kaki Pada Penderita Diabetes Mellitus*. 14(1), 35–40.
- Hall, J. E., & Hall, M. E. (2021). *Guyton and Hall Textbook of Medical Physiology* (14th ed.).
- Harli, K., Megawaty, I., Yulianti, & Yunding, J. (2023). Efektifitas Buerger Allen Exercise Terhadap Sensitivitas Kaki Pasien Dm Tipe II. *Jurnal Keperawatan*, 15(1), 81–90. <https://journal2.stikeskendal.ac.id/index.php/keperawatan/article/view/489/507>
- Mawaddah, M. (2024). Hubungan Lama Menderita Diabetes Melitus Tipe 2 Dengan Kejadian Neuropati Diabetik. *An-Najat*, 2(1), 40–46. <https://doi.org/10.59841/an-najat.v2i1.928>
- Mukaromah, I. A., Lestari, D. T., & Kartikasari, F. (2026). Buerger Allen Therapy and Foot Sensitivity in Diabetes Mellitus Patients. *Indonesian Journal of Innovation Studies*, 27(1), 1–19. <https://doi.org/10.21070/ijins.v27i1.1808>
- Novitasari, H., Widiastuti, A., & Firdaus, I. (2024). Pengaruh Buerger Allen Exercise Terhadap Sensitivitas Kaki Penderita Diabetes Meliitus Tipe Ii Di Wilayah Masaran Sragen. *JURNAL MEDIKA USADA*, 7(1), 41–48. <https://doi.org/10.54107/medikausada.v7i1.311>
- Pop-busui, R., Boulton, A. J. M., Feldman, E. L., Bril, V., Freeman, R., Malik, R. A., & Sosenko, J. M. (2017). *Diabetic Neuropathy : A Position Statement by the American Diabetes Association*. 40(January), 136–154. <https://doi.org/10.2337/dc16-2042>
- Rahmi, H., & Rasyid, W. (2023). Buerger Allen Exercise Dalam Tatalaksana Gangguan Perfusi Perifer Pada Pasien Diabetes Melitus Tipe II. *Jurnal Pengabdian Ilmu Kesehatan (JPIK)*, 2(2), 83–89. <https://doi.org/10.33757/jpik.v2i2.46>
- Smeltzer, S. C., Hinkle, J. L., Bare, B. G., & Cheever, K. H. (2010). *Brunner & Suddarth's Textbook of Medical-Surgical Nursing* (1st ed.).
- Suratun, Dani, W. R., Nabila, A. P. P., & Pandega, A. R. (2025). *Pengaruh Lahitan Buerger Allen Exercise Terhadap Perfusi Perifer Pasien Diabetes Melitus Tipe II*. 5(3), 167–186.
- Suryati, I., Murni, L., & Arnoval, B. (2019). Pengaruh Buerger Allen Exercise Terhadap Sensitivitas Kaki Pasien Diabetes Mellitus. *Prosiding Seminar Kesehatan Perintis*, 2(1), 111–111.
- Suryati, I., Murni, L., & Arnoval, B. (2020). Pengaruh Buerger Allen Exercise Terhadap Sensitivitas Kaki Pasien Diabetes Mellitus. *Prosiding Seminar Kesehatan Perintis*, 2(1), 111–111. <http://www.jurnal.stikesperintis.ac.id/index.php/PSKP/article/view/382>

- Wijayanti, D. R., & Warsono. (2022). Penerapan buerger allen exercise meningkatkan perfusi perifer pada penderita diabetes melitus tipe II. *Ners Muda*, 3(2), 155–165. <https://doi.org/10.26714/nm.v3i2.8266>
- Wulandari, S., Haskas, Y., & Abrar, E. A. (2023). Gambaran Disparitas Diabetes Melitus Tipe 2 Ditinjau Dari Faktor Sosiodemografi. *Jurnal Ilmiah Mahasiswa & Penelitian Keperawatan*, 3(6), 263–269.
- Zaki, M., Ferusgel, A., Maya, D., & Siregar, S. (2024). Hubungan Lama Menderita Dengan Kejadian Neuropati Perifer Diabetik Pada Wanita Usia Produktif Di Wilayah Kerja Puskesmas Sering Medan. *Excellent Midwifery Journal*, 1(2), 85–92.
- Arpanantikul, M., & Akbar, A. (2018). Nursing science development for nursing practice: a philosophical perspective. *International Journal of Nursing and Midwifery Science*, 2(03), 289-295.
- Akbar, A., Azizah, L. M. R., & Zainuri, I. (2018). Development of Empowerment Model of People with Mental Health Disorders in Community and Prison, to Improve Productivity and Quality of Life, in Indonesia. *Indian Journal of Public Health Research & Development*, 9(10), 163.
- Choakprasanchai, T., & Akbar, A. (2019). The Importance of Philosophical Thinking in Nursing Science. *International Journal of Nursing and Midwifery Science*, 3(2), 73-79.
- Akbar, A., Zainuri, I., Azizah, L. M. R., & Dornhofer, K. (2018). Challenge and Fighting Social Stigma in Patient with Schizophrenia in Indonesia. *International Journal of Nursing and Midwifery Science*, 2(01), 76-77.
- Akbar, A., & Junda, T. (2021). The Experience of Doctoral Nursing Candidate in Writing Publication in Journal. *NurseLine Journal*, 5(2), 241-247.
- Akbar, A., Azizah, L. M. R., & Zainuri, I. (2018). Peningkatan Kemampuan Care Giver Dalam Merawat Pasien Dengan Gangguan Jiwa Di Lembaga Sosial Rehabilitasi Penderita Gangguan Jiwa Griya Cinta Kasih Jombang.
- Akbar, A., & Sudarsih, S. (2018). Challenge in Social Support for Improving Quality of Life People with Hiv/aids. *International Journal of Nursing and Midwifery Science*, 2(02), 119-125.