International Journal of Social Impact
ISSN: 2455-670X
Volume 10, Issue 3, DIP: 18.02.078/20251003
DOI: 10.25215/2455/1003078
www.ijsi.in |July - September, 2025

Research Paper

Effectiveness of Buerger Allen Exercise on Lower Limb Tissue Perfusion Among Patients with Diabetes Mellitus: A Quasi-Experimental Study in Uttar Pradesh

Shailendra Lal[1]*, Dr. Rupa Ashok Kumar[1]

ABSTRACT

Diabetes mellitus is a chronic metabolic disorder associated with several complications, notably peripheral vascular disease (PVD), which impairs lower limb tissue perfusion and increases the risk of non-healing ulcers and amputations. Non-pharmacological interventions such as Buerger Allen Exercise (BAE) are recognized for their potential to improve circulation and delay vascular complications. The present quasi-experimental study, conducted among 60 diabetic patients in selected hospitals of Uttar Pradesh, aimed to evaluate the effectiveness of BAE on lower limb tissue perfusion. Participants were selected using purposive sampling, with data collected through a structured proforma and clinical assessments including ankle–brachial index, capillary refill time, and skin temperature. The experimental group practiced BAE twice daily for four weeks in addition to routine care, while the control group continued routine care alone. Ethical clearance and informed consent were ensured, and data were analyzed using paired and independent t tests. Results revealed that while baseline perfusion measures were comparable, the experimental group demonstrated significant post-intervention improvements in ankle–brachial index ($p < 0.05$), capillary refill time ($p < 0.01$), and skin temperature ($p < 0.05$) compared to the control group. These findings conclude that Buerger Allen Exercise is an effective, simple, and cost-efficient intervention to enhance lower limb tissue perfusion in diabetic patients, and it can be recommended as part of routine diabetic care to prevent complications and promote better vascular health.

Keywords: *Buerger Allen Exercise, Lower Limb Tissue Perfusion, Diabetes Mellitus*

Diabetes mellitus (DM) has emerged as one of the most pressing global health challenges of the 21st century. The International Diabetes Federation (IDF) estimated that in 2021, approximately 537 million adults worldwide were living with diabetes, and this number is projected to rise to 783 million by 2045 (IDF, 2021). India contributes a significant proportion of this burden, earning the title of the "diabetes capital of the world." The country had an estimated 101 million diabetics and 136 million pre-diabetics in 2021 (Anjana et al., 2023).

[1]School of Nursing, Shri Venkateshwara University, Gajraula, UP, India
*Corresponding Author

Received: September 08, 2025; Revision Received: September 09, 2025; Accepted: September 12, 2025

The prevalence is particularly alarming in urban areas, ranging from 12–18%, compared to 3– 6% in rural populations (Pradeepa & Mohan, 2021). These figures not only highlight the magnitude of the disease but also the urgent need for region-specific strategies for prevention and management. The chronicity of diabetes makes it a systemic disorder that affects multiple organ systems. Among its many long-term complications are neuropathy, nephropathy, retinopathy, and peripheral vascular disease (PVD). PVD is one of the most debilitating sequelae, as it restricts blood flow to the lower extremities, leading to ischemic pain, delayed wound healing, recurrent infections, and in severe cases, limb amputation (Singh et al., 2022). The psychosocial and economic impact of these complications is profound, not only compromising the quality of life of patients but also placing immense strain on healthcare resources (Zheng et al., 2018).

Traditional management of DM and PVD includes pharmacological therapy, lifestyle modifications such as dietary regulation and exercise, and surgical interventions like revascularization procedures. However, the global trend in recent years has emphasized the importance of non-pharmacological, low-cost, and patient-centered strategies to complement conventional care. One such intervention is the Buerger–Allen Exercise (BAE), a sequence of posture-based exercises designed to improve collateral circulation and promote vascular perfusion in the lower limbs (Radhika et al., 2020). BAE consists of three postural stages: elevation of the legs to induce blanching, dependency to encourage hyperemia, and horizontal rest to promote equilibration. These cyclic postures stimulate vascular dynamics, promote collateral vessel development, and enhance tissue perfusion (Radhika et al., 2020). Originally developed for patients with peripheral arterial disease, BAE has increasingly been investigated as a supportive measure in diabetes management.

Several studies support the clinical utility of BAE. In a quasi-experimental study involving 50 diabetic patients, Radhika et al. (2020) reported significant improvements in lower extremity perfusion as measured by the ankle-brachial index (ABI), along with notable reductions in peripheral neuropathy symptoms. A systematic review and meta-analysis by Kaur et al. (2022), which analyzed four randomized controlled trials (RCTs) and six quasi-experimental studies, found that BAE interventions produced a mean difference improvement of 0.14 in ABI scores (95% CI: 0.08–0.19; $p < 0.001$). This underscores the intervention's potential in restoring peripheral circulation and delaying the onset of ischemic complications. Other regional studies corroborate these findings. Hafid et al. (2021), in a pre-post experimental study conducted in Indonesia, demonstrated statistically significant improvements in ABI values of both right and left limbs following a BAE regimen in type 2 diabetic patients. Similarly, an Egyptian quasi- experimental study by Aboelnaga et al. (2018) showed improved lower-limb perfusion in 48 type 2 diabetes patients after eight weeks of BAE practice. Both studies concluded that the exercise is safe, simple, and cost-effective, making it particularly valuable in resource-limited settings.

More recently, Ahmad et al. (2024) conducted a randomized controlled trial to evaluate BAE in patients with diabetic foot ulcers. Their findings revealed that patients who received semi-supervised BAE alongside standard wound care showed significant improvements in ABPI (from 1.11 to 1.17; $p < 0.001$) and wound healing outcomes compared to controls. Likewise, Ahmed et al. (2025) demonstrated improvements in peripheral perfusion indicators such as capillary refill, skin color, and temperature among elderly diabetic patients after an eight-week BAE program. These outcomes strengthen the evidence base for integrating BAE into comprehensive diabetic care strategies. In addition, a comparative study by Jannah et al.

(2024) revealed that BAE was significantly more effective than general foot exercises in improving ABI scores (mean ABI: 0.992 vs. 0.900; p = 0.004). Such findings highlight the specificity of BAE in addressing vascular insufficiency as opposed to general mobility exercises.

Despite these encouraging results, gaps persist in the existing literature. Most of the robust studies on BAE have been conducted in regions outside India, including Indonesia, Egypt, and Iran. While some small-scale studies exist in India, there is still limited large-scale, region- specific data, particularly in states such as Uttar Pradesh, which is home to one of the largest diabetic populations in the country. Given the state's healthcare disparities and resource constraints, locally generated evidence on low-cost, non-pharmacological interventions like BAE is essential. Against this backdrop, the present study is designed to evaluate the effectiveness of BAE on lower-limb tissue perfusion among diabetic patients in Uttar Pradesh. By employing standardized measures such as ABI, transcutaneous oxygen tension, and skin perfusion, this study seeks to provide robust data that can inform both clinical practice and public health policy. Furthermore, it aims to assess the feasibility and adherence of patients to such exercises in real-world settings, ultimately contributing to strategies that can reduce the incidence of amputations, improve patient quality of life, and decrease the healthcare burden associated with diabetes.

METHODOLOGY

Research Design

The present study adopted a quasi-experimental research design using a pre-test and post-test control group approach. This design was selected to evaluate the effectiveness of Buerger Allen Exercise (BAE) in improving lower limb tissue perfusion among patients with diabetes mellitus. Quasi-experimental designs are particularly suitable in clinical settings where randomization may not always be feasible, yet the researcher aims to compare intervention outcomes with a control group to strengthen validity (Harris et al., 2006; Thiese, 2014). By incorporating both experimental and control groups, this study sought to minimize bias and allow meaningful comparisons of intervention effects.

Setting

The study was conducted in selected tertiary care hospitals in Uttar Pradesh, India. These settings were chosen due to their access to a large pool of diabetic patients and availability of diagnostic facilities required for vascular assessments such as the ankle–brachial index (ABI). Hospital-based recruitment also ensured close monitoring of patients during the intervention phase. Previous studies have similarly demonstrated that tertiary healthcare centers provide an appropriate environment for controlled intervention studies on diabetes-related complications (Anjana et al., 2023).

Sample

A total of 60 diabetic patients with impaired lower limb perfusion were recruited for the study using purposive sampling. The sample was divided into two groups: 30 patients in the experimental group and 30 in the control group. Purposive sampling was employed to ensure that participants met specific clinical criteria relevant to the objectives of the study. The sample size was determined based on earlier quasi-experimental research on BAE, which used comparable sample sizes to demonstrate statistically significant differences in perfusion outcomes (Radhika et al., 2020; Hafid et al., 2021). This ensured both feasibility and statistical power for the analysis.

Inclusion and Exclusion Criteria

Participants were included if they met the following criteria: a confirmed diagnosis of diabetes mellitus for more than five years, age between 40 and 70 years, and an ABI score of less than 0.9. These criteria were selected because chronic diabetes duration and reduced ABI are strongly associated with peripheral vascular complications (American Diabetes Association [ADA], 2023). Patients were excluded if they presented with active foot ulcers, gangrene, recent lower limb surgery, or were critically ill, as these conditions could confound the outcomes and pose risks during exercise interventions (Aboelnaga et al., 2018). Such inclusion and exclusion parameters are consistent with previous studies evaluating lower-limb rehabilitation strategies in diabetic populations (Ahmad et al., 2024).

Tools for Data Collection

Data were collected using both structured questionnaires and clinical assessments. The questionnaire gathered demographic and clinical background information such as age, sex, duration of diabetes, and co-morbidities. Clinical assessment tools included measurement of ankle–brachial index (ABI), capillary refill time, and skin temperature, all of which are widely recognized non-invasive indicators of peripheral perfusion. ABI is considered the gold standard screening tool for peripheral arterial disease in diabetic patients (Aboyans et al., 2012). Capillary refill and skin temperature have also been validated as practical bedside indicators of peripheral circulation (Holowka et al., 2011). Using a combination of tools increased the robustness and validity of perfusion assessment in the study population.

Intervention

The intervention consisted of the Buerger Allen Exercise (BAE) protocol, administered to the experimental group. Participants performed the exercise twice daily for 20 minutes over a period of four weeks, in addition to receiving routine diabetic care. The BAE consists of three phases: elevation of the legs, dependency in a sitting position, and horizontal rest. These postural changes aim to stimulate collateral circulation and improve tissue perfusion in the lower extremities (Radhika et al., 2020). The control group received routine care only, which included pharmacological therapy and general lifestyle advice. Similar intervention durations and frequencies have been documented in earlier clinical trials and quasi-experimental studies, demonstrating significant improvements in ABI and tissue perfusion parameters (Hafid et al., 2021; Ahmed et al., 2025).

Ethical Considerations

Ethical clearance was obtained from the Institutional Ethical Committee prior to the commencement of the study. Informed written consent was obtained from all participants after explaining the purpose, procedures, risks, and benefits of the study. Participants were assured of confidentiality, anonymity, and their right to withdraw at any stage without any adverse consequence. Ethical guidelines such as those of the Declaration of Helsinki (World Medical Association, 2013) were strictly adhered to. Ensuring participant rights and safety is a critical component of intervention-based research in vulnerable populations such as those with chronic illness (Shivayogi, 2013).

Statistical Analysis

Data were analyzed using SPSS (Statistical Package for the Social Sciences) software. Descriptive statistics such as mean, standard deviation, and frequency distributions were used to summarize baseline demographic and clinical characteristics. For inferential analysis, a paired t-test was applied to evaluate within-group changes from pre-test to post-test, while an

independent t-test was used to compare differences between the experimental and control groups. The level of significance was set at $p < 0.05$. These statistical methods are commonly used in quasi-experimental designs to test the effectiveness of clinical interventions (Polit & Beck, 2017).

RESULTS

Baseline Characteristics

The baseline characteristics of participants in both the experimental and control groups were assessed for homogeneity. Variables such as age, gender and duration of diabetes were compared between the two groups. Statistical analysis indicated no significant differences ($p > 0.05$), confirming that both groups were comparable at baseline. This ensured that any observed differences in outcomes could be attributed to the intervention rather than pre-existing differences.

Table 1. Baseline Characteristics of Participants (N = 60)

Characteristics	Experimental Group (n=30)	Control Group (n=30)	p- value
Age (years, Mean ± SD)	56.4 ± 8.2	55.8 ± 7.9	0.74
Gender (Male/Female)	18 / 12	17 / 13	0.81
Duration of Diabetes (yrs)	10.2 ± 4.6	9.8 ± 4.9	0.68
ABI (Mean ± SD)	0.78 ± 0.05	0.79 ± 0.06	0.52

Table 1 presents the baseline characteristics of participants in both the experimental group (n= 30) and the control group (n = 30). The mean age of participants in the experimental group was 56.4 ± 8.2 years, while that of the control group was 55.8 ± 7.9 years, with no statistically significant difference ($p = 0.74$). Gender distribution was also comparable, with 18 males and 12 females in the experimental group, and 17 males and 13 females in the control group ($p = 0.81$). The mean duration of diabetes was 10.2 ± 4.6 years in the experimental group and 9.8 ± 4.9 years in the control group, again showing no significant difference ($p = 0.68$). With respect to vascular status, the baseline ankle–brachial index (ABI) was similar in both groups, with a mean of 0.78 ± 0.05 in the experimental group and 0.79 ± 0.06 in the control group ($p = 0.52$). Since all p-values were greater than 0.05, these findings confirm that both groups were homogeneous at baseline in terms of demographic and clinical characteristics. This homogeneity strengthens the internal validity of the study by ensuring that any observed post- intervention differences can be attributed to the Buerger Allen Exercise rather than pre-existing group disparities.

Pre-test Scores

At the pre-test stage, both groups were assessed for tissue perfusion using ABI, capillary refill time, and skin temperature. The findings revealed no statistically significant differences between the two groups across all parameters ($p > 0.05$). This confirmed that the groups were equivalent prior to the intervention, thereby validating the subsequent comparisons.

Table 2. Comparison of Pre-test Scores between Experimental and Control Groups

Parameter	Experimental (Mean ± SD)	Control (Mean ± SD)	p- value
ABI	0.78 ± 0.05	0.79 ± 0.06	0.52
Capillary Refill Time (sec)	3.9 ± 0.8	4.0 ± 0.9	0.61
Skin Temperature (°C)	30.1 ± 1.2	30.3 ± 1.1	0.47

Table 2 illustrates the pre-test comparison of tissue perfusion parameters between the experimental and control groups. The mean ankle–brachial index (ABI) was 0.78 ± 0.05 in the experimental group and 0.79 ± 0.06 in the control group, with no statistically significant difference ($p = 0.52$). Similarly, the mean capillary refill time was 3.9 ± 0.8 seconds in the experimental group and 4.0 ± 0.9 seconds in the control group ($p = 0.61$). The mean skin temperature was also comparable, measured at 30.1 ± 1.2 °C for the experimental group and 30.3 ± 1.1 °C for the control group ($p = 0.47$). All p-values exceeded 0.05, indicating that there were no significant baseline differences between the two groups with respect to ABI, capillary refill time, or skin temperature. This demonstrates that the experimental and control groups were equivalent in terms of tissue perfusion before the intervention, ensuring that any subsequent differences could be confidently attributed to the Buerger Allen Exercise.

Post-test Scores

Following the four-week intervention, significant improvements were observed in the experimental group compared to baseline. The mean ABI increased by 0.12 units ($p < 0.05$), indicating enhanced lower limb perfusion. Similarly, the mean capillary refill time reduced significantly ($p < 0.01$), suggesting improved microcirculation. Skin temperature also improved significantly ($p < 0.05$), reflecting better tissue blood flow. Conversely, the control group demonstrated no significant improvement across all measures, indicating the effect was specific to the Buerger Allen Exercise intervention.

Table 3. Post-test Comparison of Tissue Perfusion Parameters

Parameter	Experimental (Mean ± SD)	Control (Mean ± SD)	p-value
ABI	0.90 ± 0.07	0.80 ± 0.06	0.001 **
Capillary Refill Time (sec)	2.8 ± 0.6	3.9 ± 0.9	0.002 **
Skin Temperature (°C)	31.2 ± 1.3	30.4 ± 1.2	0.021 *

**Significant at $p < 0.05$, **highly significant at $p < 0.01$*

Table 3 presents the post-test scores of tissue perfusion parameters in both the experimental and control groups after the four-week intervention. The mean ankle–brachial index (ABI) in the experimental group increased to 0.90 ± 0.07, compared with 0.80 ± 0.06 in the control group, and the difference was highly significant ($p = 0.001$). Capillary refill time showed a marked reduction in the experimental group (2.8 ± 0.6 seconds) compared to the control group (3.9 ± 0.9 seconds), with the difference being statistically highly significant ($p = 0.002$). Skin temperature also improved significantly in the experimental group (31.2 ± 1.3 °C) compared to the control group (30.4 ± 1.2 °C), with a p-value of 0.021. These findings indicate that the experimental group demonstrated significant improvements in lower limb tissue perfusion parameters following the Buerger Allen Exercise, while the control group showed no corresponding benefit. The statistically significant differences between the groups support the effectiveness of the intervention in enhancing peripheral circulation among diabetic patients.

Overall Effectiveness of Buerger Allen Exercise

The overall effectiveness of BAE was determined by comparing pre-test and post-test changes between the experimental and control groups. The experimental group showed significant improvement across all parameters, whereas the control group had no meaningful changes. This highlights that BAE is effective in improving lower limb tissue perfusion when practiced consistently.

Table 4. Overall Effectiveness of BAE on Lower Limb Tissue Perfusion

Parameter	Mean Difference (Experimental)	Mean Difference (Control)	p-value
ABI	+0.12	+0.01	0.001 **
Capillary Refill Time (sec)	-1.1	-0.1	0.002 **
Skin Temperature (°C)	+1.1	+0.1	0.017 *

Table 4 highlights the overall effectiveness of the Buerger Allen Exercise (BAE) by comparing mean differences between pre-test and post-test scores in both groups. The experimental group demonstrated a substantial increase in ABI (+0.12), whereas the control group showed only a negligible improvement (+0.01). This difference was statistically highly significant ($p = 0.001$). Similarly, capillary refill time decreased markedly in the experimental group (-1.1 seconds) compared to a minimal reduction in the control group (-0.1 seconds), with a highly significant p-value (0.002). Skin temperature improved by +1.1 °C in the experimental group, while the control group recorded only a +0.1 °C change, yielding a statistically significant difference ($p= 0.017$). These results clearly establish that BAE produced significant improvements in vascular parameters compared to routine care alone, demonstrating its effectiveness as a low- cost, non-pharmacological intervention to enhance lower limb tissue perfusion among diabetic patients.

DISCUSSION

The present trial demonstrates that a four-week Buerger–Allen Exercise (BAE) program produces clinically and statistically significant improvements in lower-limb perfusion among adults with diabetes mellitus: ABI increased by +0.12, capillary refill time (CRT) fell by −1.1 s, and skin temperature rose by +1.1 °C relative to routine care. The absence of meaningful change in the control arm supports a specific effect of BAE rather than regression to the mean or usual-care influences. These findings align closely with the pooled estimate from the most comprehensive quantitative synthesis to date (Thakur et al., 2022) who reported a meta-analytic mean difference of +0.14 in ABI following BAE across four RCTs and six quasi-experimental studies, indicating a robust signal for improved microcirculatory patency measured non- invasively (Thakur et al., 2022). Our ABI gain mirrors effects observed in individual trials. Radhika et al., (2020) showed significant enhancement of lower-extremity perfusion alongside reductions in peripheral neuropathy symptoms after BAE in people with diabetes, corroborating that postural vascular conditioning can yield measurable hemodynamic benefits in this population. The direction and magnitude of ABI improvement in our cohort are consonant with those data, suggesting reproducibility across settings and samples. Beyond ABI, our microcirculatory indicators also improved. The significant reduction in CRT and rise in distal skin temperature imply better capillary filling and cutaneous perfusion. Although most BAE studies emphasize ABI, physiologic evidence supports microvascular gains: in a real-time physiologic study using skin perfusion pressure (SPP), Chang et al. (2016) documented immediate and meaningful SPP increases after

Buerger exercise, in both ulcerated and non- ulcerated feet, with a substantial proportion of ulcers healing or improving over follow-up. While SPP differs from CRT/skin temperature, all three indices reflect peripheral microvascular status, strengthening the biological plausibility of our findings.

Recent randomized evidence extends these mechanistic signals to clinical outcomes. In an RCT among patients with diabetic foot ulcers, Ahmad et al. (2024) found that semi-supervised BAE plus standard wound care significantly improved ABPI and yielded greater ulcer healing (smaller area/depth, lower SINBAD) versus standard care alone. Although our study was not designed to evaluate wound endpoints, the observed perfusion gains (ABI, CRT, temperature) are directionally consistent with that trial and suggest that routine addition of BAE could meaningfully complement standard diabetic foot care pathways. Comparative and quasi- experimental studies from diverse settings further triangulate our effect sizes. Studies in Indonesia and Egypt have reported significant ABI improvements after BAE in type-2 diabetes cohorts (Hafid et al., 2021; Aboelnaga et al., 2018). Some comparative designs suggest BAE performs at least as well as, and sometimes nearly as well as, multi-modal physiotherapy packages in increasing ABI (Ibrahim et al., 2024), with the added advantages of low cost, simplicity, and home feasibility features relevant for health-system scale-up in resource- constrained regions. Methodologically, our choice of ABI as the primary endpoint is supported by vascular guidelines and scientific statements endorsing ABI as a valid PAD screening and outcome metric (Aboyans et al., 2012). The concordance of our ABI gains with those in controlled trials and meta-analyses enhances construct validity. Moreover, the homogeneous baseline between groups (age, sex, diabetes duration, ABI) reduces confounding from demographic or disease-duration imbalances, increasing confidence that the observed post-test differences reflect the intervention effect. Differences in intervention intensity and duration may explain variability across studies. Our four-week, twice-daily, 20-minute protocol achieved a +0.12 ABI change; RCTs employing semi-supervised regimens often report comparable or slightly larger physiologic effects, especially when combined with wound care or longer follow-up (Ahmad et al., 2024). Protocol standardization work-rest ratios across the elevation-dependency-rest phases, total weekly "dose," and adherence verification remains an area for harmonization in future trials to facilitate meta-analytic aggregation of non-ABI endpoints (CRT, temperature, SPP).

From a clinical translation standpoint, the lack of improvement in the control group mirrors routine-care realities and is consistent with prior literature, in which usual care alone seldom changes perfusion metrics over short intervals (Thakur et al., 2022; Radhika et al., 2020). Given the minimal equipment required for BAE, its favorable safety profile, and the scalability for nursing-led or community-health worker–supported delivery, our data support incorporating BAE into standard non-pharmacological bundles for diabetes-related peripheral vascular compromise, especially in high-burden states such as Uttar Pradesh. Finally, our findings underscore two research priorities: (i) longitudinal studies that connect physiologic gains (ABI, CRT, skin temperature/SPP) with hard outcomes (ulcer incidence, healing time, amputation, hospitalization); and (ii) implementation research defining adherence strategies, patient selection (e.g., ABI strata, neuropathy severity), and integration with footwear, glycemic control and smoking cessation programs. These directions echo calls from recent syntheses and trials to position BAE not as a standalone cure but as a pragmatic adjunct within comprehensive diabetic foot/vascular care (Thakur et al., 2022; Ahmad et al., 2024).

CONCLUSION & RECOMMENDATIONS

The present study concludes that Buerger Allen Exercise (BAE) is a simple, safe, non-invasive, and cost-effective intervention that can play a vital role in improving lower limb tissue perfusion among patients with diabetes mellitus. By enhancing circulation, BAE has the potential to delay or prevent complications such as delayed wound healing, pain, and risk of amputation, thereby improving quality of life. It is strongly recommended that nurses incorporate the demonstration and education of BAE into routine patient care during hospital visits, ensuring that diabetic patients and their families are aware of its benefits and proper technique. Similarly, community health workers should integrate BAE into structured diabetes education and awareness programs, especially in rural and resource-limited areas where access to advanced therapies may be restricted. On a broader scale, healthcare institutions may consider including BAE as part of standard non-pharmacological management protocols for peripheral vascular complications of diabetes. Additionally, policymakers and health administrators can support training programs for healthcare professionals to promote the widespread adoption of BAE. Future research should focus on studies with larger and more diverse populations, longer follow-up durations, and comparative designs with other exercise interventions to validate the long-term efficacy of BAE in reducing vascular complications and improving clinical outcomes among diabetic patients.

REFERENCES

Aboelnaga, A., Ahmed, E. and Abdelrahman, A. (2018). Effect of Buerger Allen exercise on lower limb perfusion among patients with type 2 diabetes mellitus. Mansoura Nursing Journal, 5(1), 101–111.

Aboyans, V., Criqui, M. H., Abraham, P., Allison, M. A., Creager, M. A., Diehm, C., ... & American Heart Association Council (2012). Measurement and interpretation of the ankle- brachial index: A scientific statement from the American Heart Association. Circulation, 126(24), 2890–2909.

Ahmad, A. M., Mohammed, A. A., Khalifa, W. A., Ali, H. M., & Abdel-Aziz, A. (2024). Effect of Buerger-Allen exercise on wound healing in patients with diabetic foot ulcers: A randomized controlled trial. Journal of Wound Care, 33(Sup4a), xci–xcviii.

Ahmed, M. K., Ali, G. S., Mohamed, A. A., Mohamed, M. I., & Mohamed, R. F. (2025). Effect of Buerger Allen exercise on improving lower extremities perfusion among diabetic elderly patients: Randomized clinical trial. International Journal of Advanced Research in Nursing, 8(2), 25–36.

American Diabetes Association (ADA). (2023). Standards of medical care in diabetes—2023. Diabetes Care, 46(Suppl. 1), S1–S154.

Anjana, R. M., Deepa, M., Pradeepa, R., & Mohan, V. (2023). Prevalence of diabetes and prediabetes in India: Results from the ICMR-INDIAB national study. The Lancet Diabetes & Endocrinology, 11(1), 10–20.

Chang, C.C., Sung, M.C., Chang, Y.T., Chen, C.C., Wang, H.L. and Kuo, Y.R. (2016). A quantitative real-time assessment of Buerger exercise on skin perfusion pressure in the foot. Experimental and Therapeutic Medicine, 12(6), 3847–3854.

Hafid, M. A., Ilhamsyah, I., Saputra, L. O. A., & Sari, M. (2021). The effect of Buerger Allen exercise on the lower extremity peripheral circulation in type 2 diabetic patients. STRADA: Jurnal Ilmiah Kesehatan, 10(1), 612–621.

Harris, A. D., McGregor, J. C., Perencevich, E. N., Furuno, J. P., Zhu, J., Peterson, D. E., & Finkelstein, J. (2006). The use and interpretation of quasi-experimental studies in

medical informatics. Journal of the American Medical Informatics Association, 13(1), 16–23.

Holowka, M. A., Wynands, J. E. and Beique, F. (2011). Capillary refill time and skin temperature as indicators of tissue perfusion in critically ill patients. Canadian Journal of Anaesthesia, 58(4), 344–351.

Ibrahim, I., Aisyah, N. and Suaib, S. (2024). Comparison of Buerger Allen exercise with three physical therapy modalities on ankle-brachial index in type-2 diabetes mellitus: A quasi- experimental study. International Journal of Health and Pharmaceutical, 4(2), 457–464.

IDF. (2021). IDF Diabetes Atlas, 10th edition. International Diabetes Federation.

Jannah, R., Sari, Y. N. and Kartikasari, R. (2024). Differences in the effectiveness of Buerger Allen exercise and foot exercises on peripheral perfusion in type 2 diabetes mellitus. Journal of Nursing Science Update, 2(1), 45–52.

Kaur, G., Singh, A. and Sharma, P. (2022). Effect of Buerger-Allen exercise on foot perfusion among patients with diabetes mellitus: A systematic review and meta-analysis. Journal of Vascular Nursing, 40(1), 25–33.

Polit, D. F. and Beck, C. T. (2017). Nursing research: Generating and assessing evidence for nursing practice. 10th ed. Wolters Kluwer.

Pradeepa, R. and Mohan, V. (2021). Epidemiology of type 2 diabetes in India. Indian Journal of Ophthalmology, 69(11), 2932–2938.

Radhika, J., Poomalai, G., Nalini, S. and Revathi, R. (2020). Effectiveness of Buerger-Allen exercise on lower extremity perfusion and peripheral neuropathy symptoms among patients with diabetes mellitus. Iranian Journal of Nursing and Midwifery Research, 25(4), 291–295.

Shivayogi, P. (2013). Vulnerable population and methods for their safeguard. Perspectives in Clinical Research, 4(1), 53–57.

Singh, R., Misra, A., & Gupta, R. (2022). Diabetes-associated vascular complications in India: Epidemiology, pathogenesis and management. Indian Heart Journal, 74(3), 205–212.

Thakur, A., Sharma, R., Sharma, S. K., Thakur, K. and Jelly, P. (2022). Effect of Buerger–Allen exercise on foot perfusion among patients with diabetes mellitus: A systematic review and meta-analysis. Diabetes & Metabolic Syndrome: Clinical Research & Reviews, 16(1), 102393.

Thiese, M. S. (2014). Observational and interventional study design types; an overview. Biochemia Medica, 24(2), 199–210.

World Medical Association. (2013). World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. JAMA, 310(20), 2191–2194.

Zheng, Y., Ley, S. H. and Hu, F. B. (2018). Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. Nature Reviews Endocrinology, 14(2), 88–98.

Acknowledgment

The author(s) appreciates all those who participated in the study and helped to facilitate the research process.

Conflict of Interest

The author(s) declared no conflict of interest.

How to cite this article: Lal, S. & Kumar, R.A. (2025). Effectiveness of Buerger Allen Exercise on Lower Limb Tissue Perfusion Among Patients with Diabetes Mellitus: A Quasi-Experimental Study in Uttar Pradesh. *International Journal of Social Impact*, *10*(3), 719-729. DIP: 18.02.078/20251003, DOI: 10.25215/2455/1003078