Jurnal Ilmiah Kesehatan Sandi Husada

Volume 13 Number 1 Juni 2024
DOI 10.35816/jiskh.v13i1.1189

ORIGINAL ARTICLES OPEN ACCESS

Effect of ankle range of motion exercise on ankle-brachial index in diabetic foot ulcer patients

Sriwahyuni Sriwahyuni*
Department of Nursing, Universitas Indonesia Timur, South Sulawesi, Indonesia

**Correspondence: Sriwahyuni, Department of Nursing, Universitas Indonesia Timur, South Sulawesi, Indonesia. email: wsri72757@gmail.com
Received: 01 April 2024 ○ Revised: 29 Mei 2024 ○ Accepted: 01 Juni 2024

ABSTRACT

Introduction: Diabetic foot ulcers are a chronic complication of diabetic mellitus that results in skin damage that can extend to tendons, muscles, bones, or joints. Foot ulcers, infections, and peripheral artery disease result in gangrene and lower extremity amputation.

Objective: determine the effect of range of motion ankle on ankle brachial index in diabetic foot ulcer patients.

Methods: Quantitative research with an approach quasy experimental design with pretest postest design. involving 10 respondents from intervention group I and 10 respondents from intervention group II. Sampling technique with non-probability concecutive sampling.

Result: there was a significant difference in the average ankle brachial index of diabetic foot ulcers between the intervention group I and the intervention group II after the ankle range of motion (p= 0.000;). Likewise, it was proven that there was no association between the length of diabetic pain (p=0.752), history of hypertension (p=0.059), smoking habit (p=0.638) and ankle brachial index of diabetic foot ulcers.

Conclusion: ankle range of motion exercises, there was a significant increase in the patient's ABI value. This increase in ABI indicates an improvement in blood circulation in the lower extremities, which is very important in the healing process of diabetic foot ulcers. Thus, the ankle range of motion exercise can be considered as one of the effective non-pharmacological interventions in the management of diabetic foot ulcers, helping to improve blood flow and speed up the wound healing process.

Keywords: ankle-brachial index; diabetic foot ulcer; a range of motion.

INTRODUCTION

Diabetes mellitus is one of the chronic diseases whose prevalence continues to increase worldwide. One of the most common complications in diabetic patients is diabetic foot ulcers, which can lead to high morbidity and potentially lead to amputation if not treated properly (Irwansyah and Kasim, 2021). Diabetic foot ulcers occur because of a combination of peripheral neuropathy, ischemia, and infection, which interfere with wound healing. Diabetes mellitus is a chronic metabolic disorder characterized by high levels of glucose in the blood, which can lead to a variety of complications, including diabetic foot ulcers (Saputra *et al.*, 2023). Diabetic foot ulcers are a serious health problem due to their high prevalence and risk of severe complications such as infection, amputation, and increased mortality (Suranta Ginting, Ihsan Kamaruddin and Lontaan, 2024a). Effective management and treatment of diabetic foot ulcers are essential to improve the quality of life and health outcomes of diabetic patients. Diabetic foot ulcers are a significant health problem due to their high prevalence and the risk of severe complications such as infection, amputation, and increased mortality (Moore *et al.*, 2021). Effective management and treatment for diabetic foot ulcers are essential to improve the quality of life and health outcomes of diabetic patients (Suprapto, 2024). Diabetic foot ulcers are a significant health problem due to their high prevalence and risk of severe consequences, such as infection, amputation, and increased mortality (Almohammadi *et al.*, 2022).

One of the main factors in the development and resistance of diabetic foot ulcers is impaired blood circulation, especially in the lower extremities. Diabetic foot ulcers (DFUs) are common sequelae of diabetes mellitus—currently, the effect of DFUs on total joint arthroplasty (Magruder *et al.*, 2024). The Ankle Brachial Index is a simple, non-invasive diagnostic tool for assessing peripheral artery disease and evaluating blood flow in the legs. An Ankle Brachial Index value of less than 0.9 indicates the presence of peripheral artery disease, which is often associated with diabetes and can complicate the healing process of foot ulcers (Koska *et al.*, 2024). The Ankle Brachial Index is essential for assessing blood circulation in the lower extremities. A low Ankle Brachial Index indicates a decrease in arterial blood flow, which is often found in patients with diabetic foot ulcers (Agyekum and Yeboah, 2024). Increased ABI is essential to support the healing of diabetic foot ulcers. One of the critical factors in the development and survival of diabetic foot ulcers is impaired blood circulation, especially in the lower extremities. The Ankle Brachial Index is a simple, non-invasive diagnostic tool for assessing peripheral artery disease and evaluating blood flow in the legs (Prasad *et al.*, 2024).

Range of Motion exercises on the ankle are one of the non-pharmacological interventions that aim to improve joint mobility, improve blood circulation, and reduce the risk of further complications (Ito *et al.*, 2024). Ankle Range of Motion exercises can help increase blood flow to the foot area, increasing the Ankle Brachial Index value. Physical therapy interventions, such as Range of Motion exercises, are commonly used to improve joint mobility, muscle strength, and overall blood circulation (Llano *et al.*, 2023). Range of Motion exercises on the ankle targets, explicitly the muscles and joints in the lower extremities, which have the potential to increase blood flow and improve Ankle Brachial Index values (Irianto *et al.*, 2023). The form of the foot training intervention is a range of motion training. Nurses perform a passive or active joint range of motion to improve comfort and safety and prevent complications in patients who cannot get out of bed. Range of Motion exercise is an isotonic form where patients and healthcare workers move each synovial joint until it reaches a complete range of motion (Fonvig *et al.*, 2024). This joint range of motion exercise includes every body activity (passive or active), including joint muscles, and with natural movements such as abduction, extension, flexion, pronation, and rotation. One of the most critical aspects when developing biomechanical models is the formulation of the joints, which, in the case of the human body, have a limited range of motion (ROM) (Rodrigues da Silva *et al.*, 2024).

The number of people with diabetes in Indonesia is so large that it requires treatment from all health teams and must involve people with diabetes mellitus themselves. Diabetes mellitus will impact the quality of human resources and considerably increase health costs. The management of diabetes mellitus must be carried out by doctors, nurses, nutritionists, and other health workers; the role of patients and families is significant. Education to patients and families aims to provide an understanding of the disease journey, prevention, complications, and management of diabetes mellitus. It will help increase family participation in efforts to improve management outcomes.

Implications for Nursing Practice. The results of this study provide a basis for nurses to integrate ROM exercises on the ankle as part of standard care for patients with diabetic foot ulcers. Nurses can teach and guide patients in performing these exercises correctly, as well as monitor the development of ABI to evaluate the effectiveness of the intervention. This study investigates the effect of Range of Motion exercise on the ankle on the Ankle Brachial Index in patients with diabetic foot ulcers. By determining whether these exercises can positively affect blood circulation and the Ankle Brachial Index, this study aims to provide evidence for incorporating Range of Motion exercises into a comprehensive management plan for diabetic foot ulcers. An increase in the Ankle Brachial Index can lead to better ulcer healing outcomes, reduce complications, and improve the quality of life of diabetic patients.

METHOD

The research design used in this research is quantitative research with a quasi-experimental design. The research carried out was by providing treatment or intervention to research subjects, namely diabetic foot ulcer patients. This research was conducted using a pretest-post-test control group design (non-randomized), namely a study that provides treatment to the study group but is previously measured or tested first (pre-test). Then, after the treatment or intervention, the study group is measured or tested again (posttest). The research was carried out from April to September 2023. The population in this study were patients who had diabetic foot ulcers. The population size was calculated based on annual reports on diabetic foot ulcer patients treated in hospitals. The sampling technique in this study was non-probability sampling with consecutive sampling; the sample size for each group was ten people. The study was divided into ten people for intervention group I and ten for intervention group II. Inclusion criteria: diabetic foot ulcers grade 1-5; age 30-60 years; willingness to be a respondent; and the patient is fully conscious.

Data Collection Tools. The questionnaire sheet containing an assessment of the patient's characteristics included the length of suffering from diabetes mellitus, history of hypertension, and smoking habits. Evaluation of the Ankle Brachial Index value and Observation sheet of Range of Motion ankle activities. Validity and Reliability of Instruments. In this study, a questionnaire or list of questions about demographic data and Ankle Brachial Index (ABI) examination on respondents before and after doing the Range of Motion of the ankle was used on different respondents and at other times using the "Mercury Sphygnometer" tool. The tool is still new and has been tested for validity by the factory. The use of this tool to measure blood pressure more than 50 times or at least once every three months is tested for validity or calibrated using a unique tool called quality control (QC). Data analysis: Univariate and bivariate analyses are presented as tables and descriptions. This research applies the concepts of fidelity ethics, Benefits, Autonomy, Justice, and Nonmaleficence.

RESULTS

Table 1. Characteristics of respondents

Responsive Features	Intervention group I		Intervention Group II		Amount	
	Amount		Amount			
	N	%	N	%	n	%
Gender						
Man	5	25	3	15	8	40
Women	5	25	7	35	12	60
Education						
Low	4	20	5	25	9	45
Tall	6	30	5	25	11	55
Duration of illness						
< 5 Year	4	20	5	25	9	45
≥ 5 Year	6	30	5	25	11	65
History of hypertension						
Yes	4	20	3	15	7	35
No	6	30	7	35	13	65
Smoking habits						
Yes	4	20	4	20	8	40
No	6	30	6	30	12	60

Table 2. Changes in ABI in intervention group I before and after ankle ROM

Intervention group I	Mean	SD	SE	*P value*	n
Before	0,65	0,08	0,026	0,000	20
After	0,72	0,09	0,029		
Intervention group II					
Before	0,63	0,10	0,03	0,000	20
After	0,71	0,11	0,03		

Based on Table 2, it was found that the average ABI value for intervention group I before was 0.65 with a standard deviation of 0.08, while for intervention group I after, the average ABI value was 0.72 with a standard deviation of 0.9. The statistical test results obtained a value of p = 0.000, meaning that at alpha 5%, there was a significant change in the average ABI value between intervention group I before and after ankle ROM was carried out. The average ABI value for the intervention group II before was 0.63 with a standard deviation of 0.10, while for the intervention group II after, the average ABI value was 0.71 with a standard deviation of 0.11. The statistical test results obtained a value of p = 0.000, meaning that at alpha 5%, there was a significant change in the average ABI value between intervention group II before and after ankle ROM was carried out.

Table 3. Difference in average ABI in intervention group I and intervention group II before and after ankle ROM

Group	Mean	SD	SE	*P value*	n
Before					
Intervention I	0,65	0,08	0,8	0,801	20
Intervention II	0,63	0,10	0,10		
After					
Intervention I	0,72	0,09	0,02	0,852	20
Intervention II	0,71	0,11	0,03		

Based on table 3. The average ABI value of the first intervention group was 0.65 with a standard deviation of 0.08; for the second intervention group, the average ABI value was 0.63 with a standard deviation of 0.10. The statistical test results obtained a value of p = 0.801, meaning

that at alpha 5%, there was no significant difference in the average ABI score between intervention groups I and II before ROM ankle was performed. The average ABI value of the first intervention group was 0.72 with a standard deviation of 0.09; for the second intervention group, the average ABI value was 0.71 with a standard deviation of 0.11. The statistical test results obtained a value of p = 0.852, meaning that at alpha 5%, there was no significant difference in the average ABI value between intervention groups I and II after the ankle ROM was carried out. Thus, it can be concluded that ankle ROM exercises may increase ABI values in patients with diabetic foot ulcers. However, there was no significant difference in the increase in ABI values between the two intervention groups. ROM exercises on the ankle were beneficial for improving blood circulation, and ABI values in general, but their effectiveness was similar between the intervention groups studied.

DISCUSSION

The results of this study show that ankle ROM exercises may increase ABI values in patients with diabetic foot ulcers. However, there was no significant difference in the increase in ABI values between the two intervention groups. ROM exercises on the ankle were beneficial for improving blood circulation, and ABI values in general, but their effectiveness was similar between the intervention groups studied. ROM exercises on the ankle help increase ABI values and improve blood circulation in patients with diabetic foot ulcers. Although the effectiveness was similar between the groups studied, this exercise could be essential to diabetic foot ulcer management in nursing practice (Durán-Sáenz *et al.*, 2022). ROM exercises on the ankle can be integrated into the nurse's daily care plan. Educating patients and families about the importance of these exercises and how to do them correctly can improve compliance and effectiveness of interventions (Bernard *et al.*, 2023). Although there was no statistically significant difference between the groups, the observed increase in ABI had important clinical implications. Increased ABI can help reduce the risk of complications related to poor blood circulation, such as infection and amputation, and improve patients' quality of life with diabetic foot ulcers (Visonà *et al.*, 2020).

ROM exercises on the ankle involve both active and passive movements that improve the mobility of the joints and muscles around the ankle. This movement helps stimulate blood flow and improves the oxygenation of tissues in the lower extremities (Rahiminezhad *et al.*, 2022). By improving blood circulation, ROM exercises can help reduce ischemia and accelerate the healing of diabetic foot ulcers. Patients who performed ROM exercises on the ankle experienced increased ABI values, reflecting improved blood circulation in the legs (Sharma, Sharma and Chahal, 2024). The increase in ABI suggests that this exercise effectively reduces the blockage or narrowing of the arteries that often occur in patients with diabetes and PAD (Lee and Jeong, 2024). Increasing ABI scores through ROM exercises have significant clinical benefits. Improving blood circulation can reduce the risk of complications such as infection and amputation. In addition, improving blood circulation can improve a patient's quality of life by reducing the pain and discomfort associated with diabetic foot ulcers (Wang *et al.*, 2024).

Many clinical management strategies have been proposed to deal with diabetic foot ulcers. However, the occurrence and recurrence of foot ulcers remain the major problems for people with diabetes. ROM exercises on the ankle showed a significant increase in ABI values in patients with diabetic foot ulcers (Wang, Wang and Zheng, 2024). ABI is an essential indicator for assessing blood flow in the lower extremities and detecting the presence of peripheral artery disease (PAD). An increase in ABI values after ROM training shows an improvement in blood flow, which can help heal foot ulcers (Zhao *et al.*, 2024). ROM exercises on the ankle involve repetitive and varied joint movements, which can improve blood flow to the area through vasodilation mechanisms and increased muscle pump activity. This movement helps increase oxygenation and nutrients to damaged tissues and secrete metabolic products that can slow wound healing. Significant increase in ABI values after ROM exercise and statistical analysis showed no significant difference

between the intervention groups (Kulprachakarn *et al.*, 2022). This suggests that both groups experience similar benefits from ROM exercises, which confirms the effectiveness of these exercises in general regardless of individual or group variation.

Although not statistically significant, the increase in ABI values between groups suggests that ROM exercises still have significant clinical benefits. Increased blood circulation indicated by higher ABI values can reduce the risk of complications such as infection and amputation, often in diabetic foot ulcers (Spearman *et al.*, 2020). Educating patients and families about the importance of ROM exercises and how to do them correctly is essential to ensure compliance and effectiveness of the intervention (Strömberg *et al.*, 2002). Patients need to understand how these exercises can help improve blood circulation and speed up wound healing. Good blood circulation is essential for foot health, especially in patients with diabetes (Sharma *et al.*, 2024). Blood carries oxygen and nutrients necessary for wound healing and tissue repair. Smooth blood flow also helps to remove waste products and toxins from the injured area. With a good understanding of the importance of ROM exercises, patients can be more motivated to do the exercises regularly and correctly, thus helping to improve blood circulation and accelerate the healing of diabetic foot ulcers.

CONCLUSION

It can be concluded that ankle ROM exercises may increase ABI values in patients with diabetic foot ulcers. However, there was no significant difference in the increase in ABI values between the two intervention groups. ROM exercises on the ankle were beneficial for improving blood circulation and ABI values in general, but the effectiveness was similar between the intervention groups studied. ROM exercises on the ankle can be included as a routine part of a rehabilitation program for patients with diabetic foot ulcers to help improve blood circulation and improve wound healing. By adopting ROM exercises in nursing practice, it is hoped that nurses can provide more effective care, improve patient health outcomes, and contribute to developing evidence-based nursing science.

Conflicts of Interest:

The authors declare no conflict of interest.

REFERENCE

Agyekum, J. A. and Yeboah, K. (2024) 'Phase angle associated is with low ankle-brachial index in type 2 diabetes patients in Ghana', *Diabetes Epidemiology and Management*, 15, p. 100216. doi: 10.1016/j.deman.2024.100216.

Almohammadi, A. A. *et al.* (2022) 'Pattern and type of amputation and mortality rate associated with diabetic foot in Jeddah, Saudi Arabia: A retrospective Cohort Study', *Annals of Medicine & Surgery*, 73, p. 103174. doi: 10.1016/j.amsu.2021.103174.

Bernard, T. L. *et al.* (2023) 'Nurse-led heart failure educational interventions for patient and informal caregiver dyads: An integrative review', *Heart & Lung*, 59, pp. 44–51. doi: 10.1016/j.hrtlng.2023.01.014.

Durán-Sáenz, I. *et al.* (2022) 'Knowledge and teaching-learning methods regarding venous leg ulcers in nursing professionals and students: A scoping review', *Nurse Education in Practice*, 63, p. 103414. doi: 10.1016/j.nepr.2022.103414.

Fonvig, C. E. *et al.* (2024) 'Limited associations between passive range of motion and gross motor function in ambulant/semi-ambulant children and adolescents with cerebral palsy: A cross-sectional study', *Journal of Bodywork and Movement Therapies*, 39, pp. 170–175. doi: 10.1016/j.jbmt.2024.02.030.

Irianto, I. *et al.* (2023) 'Physiotherapy Management in Postoperative Anterior Cruciate Ligament', *Jurnal Ilmiah Kesehatan Sandi Husada*, 12(1), pp. 247–254. doi: 10.35816/jiskh.v12i1.1035.

Irwansyah, I. and Kasim, I. S. (2021) 'Indentifikasi Keterkaitan Lifestyle Dengan Risiko Diabetes

Melitus', *Jurnal Ilmiah Kesehatan Sandi Husada*, 10(1), pp. 62–69. doi: 10.35816/jiskh.v10i1.511.

Ito, Y. *et al.* (2024) 'Passive shoulder abduction range of motion at 3 months postoperatively is the most important prognostic factor for achieving full recovery of range of motion at 6 months after arthroscopic rotator cuff repair', *JSES International*. doi: 10.1016/j.jseint.2024.03.010.

Koska, J. *et al.* (2024) 'Relationship of apolipoprotein C-III proteoform composition with ankle-brachial index and peripheral artery disease in the Multi-Ethnic Study of Atherosclerosis (MESA)', *Atherosclerosis*, 395, p. 117584. doi: https://doi.org/10.1016/j.atherosclerosis.2024.117584.

Kulprachakarn, K. *et al.* (2022) 'Effectiveness of combined conventional treatment with a tailored exercise training program on wound healing in patients with venous leg ulcer: A randomized controlled trial', *Journal of Tissue Viability*, 31(1), pp. 190–196. doi: 10.1016/j.jtv.2021.06.010.

Lee, J. H. and Jeong, W. K. (2024) 'Effects of humeral head stabilization intervention during aggressive manual passive stretching exercises in patients with painful stiff shoulder: A prospective, comparative study', *Journal of Shoulder and Elbow Surgery*. doi: 10.1016/j.jse.2024.01.048.

Llano, L. *et al.* (2023) 'Very early prescription of range of motion exercises in ankle fractures treated with ORIF does not increase the rate of complications and reoperations: A survival risk analysis', *Injury*, 54, p. 111019. doi: 10.1016/j.injury.2023.111019.

Magruder, M. L. *et al.* (2024) 'History of Diabetic Foot Ulcer is Associated With Increased Risk of Prosthetic Joint Infection and Sepsis After Total Joint Arthroplasty', *The Journal of Arthroplasty*, 39(1), pp. 250–254. doi: 10.1016/j.arth.2023.07.015.

Moore, Z. *et al.* (2021) 'Diabetic foot ulcers: treatment overview and cost considerations', *Journal of Wound Care*, 30(10), pp. 786–791. doi: 10.12968/jowc.2021.30.10.786.

Prasad, A. *et al.* (2024) 'A high burden of diabetes and ankle brachial index abnormalities exists in Mexican Americans in South Texas', *Preventive Medicine Reports*, 38, p. 102604. doi: 10.1016/j.pmedr.2024.102604.

Rahiminezhad, E. *et al.* (2022) 'A randomized controlled clinical trial of the effects of range of motion exercises and massage on muscle strength in critically ill patients', *BMC Sports Science, Medicine and Rehabilitation*, 14(1), p. 96. doi: 10.1186/s13102-022-00489-z.

Rodrigues da Silva, M. *et al.* (2024) 'A methodology to restrict the range of motion of joints: Application to the ankle joint complex', *Mechanism and Machine Theory*, 198, p. 105654. doi: 10.1016/j.mechmachtheory.2024.105654.

Saputra, M. K. F. *et al.* (2023) 'Analysis of the Occurrence of Diabetic Wounds in People with Diabetes Mellitus', *Jurnal Ilmiah Kesehatan Sandi Husada*, 12(1), pp. 143–149. doi: 10.35816/jiskh.v12i1.915.

Sharma, A. *et al.* (2024) 'Insights of biopolymeric blended formulations for diabetic wound healing', *International Journal of Pharmaceutics*, 656, p. 124099. doi: 10.1016/j.ijpharm.2024.124099.

Sharma, A., Sharma, N. and Chahal, A. (2024) 'Impact of Virtual Reality on Pain, ROM, Muscle Strength and Quality of Life among Breast Cancer Patients: An Integrative Review of Literature', *Pain Management Nursing*. doi: 10.1016/j.pmn.2024.04.015.

Spearman, A. D. *et al.* (2020) 'Hepatic Vein Blood Increases Lung Microvascular Angiogenesis and Endothelial Cell Survival—Toward an Understanding of Univentricular Circulation', *Seminars in Thoracic and Cardiovascular Surgery*, 32(4), pp. 980–987. doi: 10.1053/j.semtcvs.2020.03.004.

Strömberg, A. *et al.* (2002) 'Interactive education on CD-ROM—a new tool in the education of heart failure patients', *Patient Education and Counseling*, 46(1), pp. 75–81. doi: 10.1016/S0738-3991(01)00151-3.

Suprapto, S. (2024) 'Optimization of public health through counseling on diabetes mellitus', *Jurnal Pengabdian Masyarakat Edukasi Indonesia*, 1(1), pp. 01–08. doi:

10.61099/jpmei.v1i1.31.
Suranta Ginting, D., Ihsan Kamaruddin, M. and Lontaan, A. (2024a) 'Promotive and preventive education of non-communicable diseases for the community', *Jurnal Pengabdian Masyarakat Edukasi Indonesia*, 1(2), pp. 56–62. doi: 10.61099/jpmei.v1i2.41.
Visonà, A. *et al.* (2020) 'Abnormal ankle-brachial index (ABI) predicts primary and secondary cardiovascular risk and cancer mortality', *European Journal of Internal Medicine*, 77, pp. 79–85. doi: 10.1016/j.ejim.2020.02.033.
Wang, Y. *et al.* (2024) 'An observational study of the pH value during the healing process of diabetic foot ulcer', *Journal of Tissue Viability*, 33(2), pp. 208–214. doi: 10.1016/j.jtv.2024.03.015.
Wang, Y., Wang, C. and Zheng, L. (2024) 'Bibliometric analysis of systematic review and meta-analysis on diabetic foot ulcer', *Heliyon*, 10(6), p. e27534. doi: 10.1016/j.heliyon.2024.e27534.
Zhao, N. *et al.* (2024) 'Application of a Diabetic Foot Smart APP in the measurement of diabetic foot ulcers', *International Journal of Orthopaedic and Trauma Nursing*, 54, p. 101095. doi: 10.1016/j.ijotn.2024.101095.

How to cite this article: Sriwahyuni, S. (2024) "Effect of ankle range of motion exercise on ankle-brachial index in diabetic foot ulcer patients", Jurnal Ilmiah Kesehatan Sandi Husada, 13(1), pp. 131-138. doi: 10.35816/jiskh.v13i1.1189.