HTechJ Health and Technology Journal (HTechJ)

Volume 03 Number 06
December 2025
p-ISSN: 2986-5662
e-ISSN: 2985-959X

Ankle Pump Exercise and Foot Massage Intervention on Reducing Leg Edema in Chronic Kidney Disease (CKD) Patients

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Abstract:
Chronic Kidney Disease (CKD) is a significant health problem with increasing prevalence, characterized by a progressive decline in kidney function resulting in fluid accumulation in the body. One common clinical manifestation is edema in the lower extremities. Ankle pump exercises and foot massage are non-pharmacological interventions that can help reduce edema by improving venous and lymphatic circulation. This study aims to analyze the implementation of nursing care in relation to the effect of ankle pump exercise and foot massage on reducing leg edema in patients with chronic kidney disease (CKD). This study used a case study design with a nursing care approach in a CKD patient with edema in the Anturium Ward of Dr. Soebandi Regional General Hospital, Jember. Ankle pump exercises were performed for 10 minutes, followed by a 15-minute foot massage, which was repeated for three consecutive days of treatment. The degree of edema was evaluated using the edema pitting scale before and after the intervention. The results showed a decrease in edema from +2 to +1 (1 mm in the left leg) and from +1 to 0 (2 mm in the right leg). There was also a decrease in ankle circumference of 20 cm and instep of 25.5 cm on the right leg, and 19 cm at the ankle and 23.7 cm at the left leg. Furthermore, muscle strength increased from 2 cm to 5 cm in the left leg and from 1 cm to 4 cm in the right leg. Ankle pump exercises and foot massage effectively reduce edema in CKD patients. This therapy can be used as an independent nursing intervention to enhance the quality of life for patients with CKD who experience edema.

Article info:
Submitted:
06-08-2025
Revised:
18-11-2025
Accepted:
21-11-2025

Keywords:
chronic kidney disease; edema; ankle pump exercise; foot massage; nursing care

DOI: https://doi.org/10.53713/htechj.v3i6.462

INTRODUCTION

Chronic Kidney Disease (CKD) is a progressive, irreversible decline in renal function lasting more than three months, characterized by the kidneys diminished capacity to filter metabolic waste, regulate fluid-electrolyte balance, and maintain homeostasis (Reddi, 2022). As the disease advances, patients often progress to end-stage renal disease (ESRD), necessitating renal replacement therapy such as hemodialysis to sustain life (Gupta et al., 2021). Hemodialysis serves as a mechanical substitute for kidney function, removing accumulated toxins and excess fluid from the bloodstream (Ahmed et al., 2025). However, despite the life-sustaining nature of this intervention, it does not fully restore physiological balance, leaving patients vulnerable to a host of complications that significantly impact their quality of life (Maurya, 2025).

One of the most prevalent and clinically significant complications among CKD patients, particularly those on hemodialysis, is peripheral edema—most notably in the lower extremities (Alkhaqani, 2022). This condition arises from the kidneys' inability to excrete sodium and water

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December 2025
p-ISSN: 2986-5662
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adequately, leading to fluid retention and increased capillary hydrostatic pressure. Gravity further exacerbates fluid accumulation in dependent areas such as the feet and legs (Kim, 2023). Additional contributing factors include prolonged immobility during dialysis sessions, impaired venous return due to muscle weakness, and hypoalbuminemia resulting from protein loss and malnutrition. These factors collectively promote interstitial fluid leakage and hinder lymphatic drainage, perpetuating chronic swelling (Young, 2021).

The consequences of untreated edema extend beyond physical discomfort, including a sensation of heaviness and tightness in the limbs, restricted mobility, diminished functional capacity, and an elevated risk of skin breakdown, pressure ulcers, and secondary infections (Ameh et al., 2023). For hemodialysis patients—who often endure long, sedentary treatment sessions—the persistence of edema can lead to reduced adherence to therapy, decreased participation in rehabilitation, and overall poorer clinical outcomes (Doan et al., 2024). Consequently, addressing edema through non-pharmacological, evidence-based interventions is not merely supportive but essential in comprehensive nursing care for this population (Alshammari et al., 2025).

Ankle pump exercises have emerged as a simple, cost-effective, and safe non-pharmacological strategy to mitigate lower limb edema in CKD patients (Gul et al., 2021). This active movement involves rhythmic dorsiflexion and plantarflexion of the ankle joint, which acts as a physiological “muscle pump” to enhance venous return from the lower extremities (Maharem et al., 2022). By compressing deep veins during contraction and facilitating unidirectional flow toward the heart, ankle pumps reduce venous stasis, improve circulation, and promote fluid mobilization. Multiple clinical studies have demonstrated its efficacy in reducing edema severity and lowering the risk of deep vein thrombosis in patients with compromised renal function (Li et al., 2022).

Complementing ankle pump exercises, foot massage has also been recognized as a valuable adjunct therapy in managing edema. Manual stimulation of the feet and lower legs enhances both blood and lymphatic circulation, reduces muscle tension, and facilitates the reabsorption of interstitial fluid (Sahran et al., 2024). The mechanical pressure applied during massage helps overcome the resistance posed by accumulated fluid, while also promoting relaxation and reducing pain perception (Ren et al., 2021). Importantly, foot massage is non-invasive, easily integrated into routine dialysis care, and well-tolerated by patients, making it an ideal component of holistic nursing interventions (Çeçen & Lafcı, 2021).

Despite the growing body of evidence supporting these interventions, their systematic implementation and evaluation within the context of hemodialysis units—particularly in resource-constrained settings—remain underexplored. There is a critical need for localized context-specific research that examines the feasibility, adherence, and clinical impact of combining ankle pump exercises and foot massage in real-world nursing practice. Such studies are essential to inform standardized protocols and elevate the quality of nursing care delivered to CKD patients (Rias et al., 2024).

This study aims to describe and analyze the implementation of nursing care interventions involving ankle pump exercises and foot massage in reducing lower limb edema among patients with chronic kidney disease undergoing hemodialysis at the Anturium Room of Dr. Soebandi Regional Hospital. By documenting the process, patient responses, and observed outcomes, this research seeks to provide actionable insights for nursing practice, contribute to evidence-based guidelines for non-pharmacological edema management, and ultimately improve the comfort, mobility, and overall well-being of CKD patients in a clinical setting (Lightfoot et al., 2023).

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STUDY DESIGN

This study employs a case study research design with a nursing care approach, which generally describes nursing care for patients with chronic kidney disease and lower extremity edema at RSD, Dr. Soebandi Jember. The sample of this study was an adult patient with a diagnosis of CKD at RSD. Dr. Soebandi Jember was hospitalized in the Anturium Room and voluntarily agreed to participate in the study, having signed an informed consent form. Data collection took place in February 2025 at the Anturium Room RSD, Dr. Soebandi, Jember.

The primary data source in this study came from nursing assessments of CKD patients and their families, subjectively and objectively. While the secondary data source obtained came from patient medical record reports at RSD, Dr. Soebandi Jember. The research instruments used in this study included the medical-surgical nursing assessment format from the Faculty of Nursing, University of Jember, standard operating procedures (SOPs) for providing ankle pump exercise techniques and foot massage techniques, and observation sheets to assess the degree of patient extremity edema before and after the intervention. Edema measurement used a pitting edema scale measuring instrument with an SLKI edema indicator (L.03020).

This study was approved by the Ethics Committee of the Faculty of Nursing, Universitas Jember, ensuring full compliance with ethical standards for research involving human participants. All procedures were conducted in accordance with the principles outlined in the Declaration of Helsinki and institutional ethical guidelines. Written informed consent was obtained from all participants prior to enrollment, and confidentiality of personal and clinical data was strictly maintained throughout the study.

PATIENT INFORMATION

The patient managed in this scientific work is Mrs. A., 48 years old, with a medical diagnosis of chronic kidney disease (CKD) stage V since the end of August 2024 at RSD Balung. The patient also began complaining of shortness of breath when she was first brought to the hospital. The patient's previous medical history was DM since 17 years ago, namely when she was 31 years old, and hypertension since 13 years ago, namely at the age of 35 years. The patient regularly takes DM and hypertension medication from the doctor.

During treatment at RSD Balung, the patient received DM treatment and hemodialysis 3 times with the installation of an AV Shunt in the right thigh. However, after the dialysis, the AV Shunt could no longer be used because of a blockage in the channel. Therefore, the patient was referred to RSD Dr. Soebandi to have a CVC installed in the neck and continue hemodialysis there. Before the CVC was installed, the AV Shunt in the right thigh was surgically removed, and the CVC was used in early December. Since then, the patient has routinely attended checkups at the BTKV polyclinic according to schedule and undergone routine hemodialysis at RSD Dr. Soebandi Hospital once a week, on Wednesday nights, to date.

After the AV shunt on his right thigh was removed, the patient felt discomfort when moving his leg, especially when walking. Hence, his activities, such as exercising and doing household chores, began to decrease. In addition to regular checkups at the BTKV and hemodialysis clinics, the patient also regularly checks himself at the internal medicine clinic due to his CKD and hypertension. Before the MRS, the patient complained of swollen thighs, and one day before the MRS, his legs were swollen, accompanied by shortness of breath and nausea. The patient was taken to Dr. Soebandi Hospital for an examination at the internal medicine clinic, and the doctor recommended monitoring with inpatient care.

CLINICAL FINDINGS

During the January 11, 2025, assessment, at 07.00 WIB, the patient complained of swelling in both legs and difficulty moving. During the physical examination, there was grade 2 pitting edema with a depth of 4 mm in the right and left legs, and the peripheral pulses felt in the extremities were deep. When the lower extremity muscle strength was examined, the results showed a decrease in muscle strength, namely 3333/3333, and a decreased range of motion, namely 4/4. Based on the results of laboratory tests, there was an increase in all kidney function component values, namely serum creatinine 5.8 mg/dL (normal: 0.5-1.1), BUN 49 mg/dL (normal: 6-20), and urea 104 mg/dL (normal: 12-43). Upon examination of body weight and height, the current weight is 65 kg, and height is 152 cm, with a BMI of 28.2 kg/m². The patient reported that he could still urinate, but that he had been passing less urine recently, at 300 cc/24 hours (oliguria). He appeared weak and was bedridden.

THERAPEUTIC INTERVENTION

The therapeutic interventions provided were ankle pump exercise therapy and foot massage as non-pharmacological nursing strategies to reduce leg edema in CKD patients. The interventions were conducted three times daily (8:00 AM, 2:00 PM, and 8:00 PM) for three consecutive days, each lasting 30 minutes. The intervention procedures were as follows:

1. Measure pitting edema, leg circumference, and range of motion in the right and left legs before the ankle pump exercise and foot massage therapy.
2. Perform 10 minutes of ankle pump exercise, alternating between the right and left legs.
3. Rest both legs for 5 minutes.
4. Perform 15 minutes of foot massage, alternating between the right and left legs.
5. Measure pitting edema, leg circumference, and range of motion in the right and left legs before the ankle pump exercise and foot massage therapy.

Pitting Edema and Muscle Strength

Table 1. Pitting Edema and Muscle Strength

Day	Intervention	Foot	Pitting Edema		Muscle Strength	
			Pre	Post	Pre	Post
1	1	Dextra	+2 (4 mm)	+2 (4 mm)	+ 1 cm	+ 1 cm
		Sinistra	+2 (4 mm)	+2 (4 mm)	+ 2 cm	+ 2 cm
	2	Dextra	+2 (4 mm)	+2 (4 mm)	+ 1 cm	+ 1 cm
		Sinistra	+2 (4 mm)	+2 (4 mm)	+ 3 cm	+ 3 cm
	3	Dextra	+2 (4 mm)	+2 (3 mm)	+ 1 cm	+ 1 cm
		Sinistra	+2 (4 mm)	+2 (3 mm)	+ 3 cm	+ 3 cm
2	1	Dextra	+2 (3 mm)	+2 (3 mm)	+ 2 cm	+ 2 cm
		Sinistra	+2 (3 mm)	+2 (3 mm)	+ 4 cm	+ 4 cm
	2	Dextra	+2 (3 mm)	+2 (3 mm)	+ 2 cm	+ 2 cm
		Sinistra	+2 (3 mm)	+2 (3 mm)	+ 4 cm	+ 4 cm
	3	Dextra	+2 (3 mm)	+1 (2 mm)	+ 2 cm	+ 3 cm
		Sinistra	+2 (3 mm)	+1 (2 mm)	+ 4 cm	+ 4 cm
3	1	Dextra	+1 (2 mm)	+1 (2 mm)	+ 3 cm	+ 3 cm
		Sinistra	+1 (2 mm)	+1 (2 mm)	+ 4 cm	+ 4 cm
	2	Dextra	+1 (2 mm)	+2 (2 mm)	+ 4 cm	+ 4 cm
		Sinistra	+1 (2 mm)	+2 (1 mm)	+ 5 cm	+ 5 cm

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p-ISSN: 2986-5662
e-ISSN: 2985-959X

The table above shows that the three-day intervention of ankle pump exercises and foot massage reduced edema to grade 1 with a depth of 2 mm in the right leg and grade 1 with a depth of 1 mm in the left leg. The table above shows an increase in muscle strength, from initially being able to shift and lift 2 cm to 5 cm in the left leg and from 1 cm to 4 cm in the right leg.

Foot Circumference Size

Table 2. Foot Circumference Size

Day	Intervention	Foot	Circumference	Pitting Edema	
				Pre	Post
1	1	Dextra	Ankle	24	24
			Instep	33.5	29
		Sinistra	Ankle	23	23
			Instep	30	26
	2	Dextra	Ankle	23.5	23
			Instep	29.5	28
		Sinistra	Ankle	22.5	22
			Instep	30	29
	3	Dextra	Ankle	23	22.5
			Instep	28	28
		Sinistra	Ankle	22	21.5
			Instep	29	28.4
2	1	Dextra	Ankle	22.5	22
			Instep	28	27.5
		Sinistra	Ankle	21.5	21
			Instep	28.4	26
	2	Dextra	Ankle	22	21.5
			Instep	27.5	27
		Sinistra	Ankle	21	20.5
			Instep	26	25
	3	Dextra	Ankle	21.5	21
			Instep	27	26.5
		Sinistra	Ankle	20.5	20
			Instep	25	24.6
3	1	Dextra	Ankle	21	20.5
			Instep	26.5	26
		Sinistra	Ankle	20	19.5
			Instep	24.6	24
	2	Dextra	Ankle	20.5	20
			Instep	26	25.5
		Sinistra	Ankle	19.5	19
			Instep	24	23.7

The table above shows that the three-day intervention of ankle pump exercises and foot massage resulted in a decrease in leg circumference to 20 cm at the ankle and 25.5 cm at the instep on the right leg, and to 19 cm at the ankle and 23.7 cm at the instep on the left leg.

DISCUSSION

Several factors contribute to edema reduction through ankle pump exercise and foot massage therapy. These include interventions that increase venous flow and muscle pump function. Ankle pump exercise increases calf muscle contractions and optimizes venous return, reducing fluid stasis in the extremities. Meanwhile, foot massage can increase lymphatic flow and provide a relaxing

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effect. Foot massage therapy stimulates lymphatic flow and capillary circulation, reduces capillary permeability, and calms the sympathetic nervous system, thereby reducing fluid exudation. This reinforces the hypothesis that the mechanical effects of the muscle pump and increased lymphatic function work synergistically (Maharem, 2022).

These findings align with several previous studies that highlight the benefits of these non-pharmacological interventions in improving peripheral circulation and facilitating the reabsorption of interstitial fluid. Ankle pump exercise works by stimulating calf muscle contractions, which act as a "muscle pump," physiologically increasing venous return from the lower extremities to the heart. This mechanism helps reduce venous stasis, a major contributor to edema in patients with chronic kidney disease. Furthermore, rhythmic flexion and extension movements of the ankle joint also encourage fluid retained in soft tissues to return to the circulatory system (Sakai et al., 2021).

Foot massage is a therapeutic intervention that enhances lymphatic flow and promotes capillary blood circulation through gentle, rhythmic pressure applied to the feet and lower extremities, facilitating the mobilization and reabsorption of interstitial fluid trapped in tissues (Songwathana et al., 2025). Beyond its mechanical effects, foot massage induces a profound relaxing response by stimulating parasympathetic nervous system activity and reducing sympathetic overdrive, which helps to normalize vascular tone and decrease excessive capillary permeability—key contributors to edema formation. This neurophysiological modulation not only supports fluid homeostasis but also alleviates muscle tension, reduces pain perception, and improves overall patient comfort, making foot massage a valuable, non-invasive adjunct in the nursing management of edema among patients with chronic kidney disease, particularly during hemodialysis when fluid retention and autonomic dysregulation are common. (Sahran et al., 2024).

Based on the evaluation results, the patient's edema level decreased after three days of intervention, as per the three-times-a-day schedule. However, there were confounding factors during this implementation because the patient received hemodialysis therapy once on the third day of hospitalization and furosemide therapy, 40 mg every morning, in the Anturium Room of Dr. Soebandi Jember Regional Hospital. Hemodialysis therapy is a medical therapy that cleans the blood of harmful substances and reduces excess fluid that damaged kidneys cannot excrete. Meanwhile, furosemide injection therapy is a class of diuretic drugs used to reduce edema due to fluid retention. Hemodialysis is generally beneficial in reducing excess fluid volume; however, residual edema in the patient's legs can persist, particularly if not supported by elevation or additional therapy. The dose of fluid removed during the hemodialysis process typically decreases throughout the session. However, the effects of local edema often take several days to disappear or require several days after hemodialysis to show a significant decrease (Smith et al., 2024).

In patients undergoing hemodialysis without targeted intervention, pitting edema typically resolves slowly and inconsistently, often taking more than three days to show any measurable reduction, with changes that are subtle, non-uniform, and rarely quantified in clinical practice. In contrast, patients who receive structured interventions, such as ankle pump exercises and foot massage, demonstrate a rapid and clinically significant reduction in edema, with visible improvement often observed within the first 24 hours and a marked reduction achieved by the third day. Objective measurements, such as leg circumference, reveal a consistent decrease of approximately 2–3 mm over the 72 hours, reflecting improved fluid mobilization and enhanced venous and lymphatic return. This accelerated and quantifiable response underscores the efficacy of non-pharmacological interventions in managing fluid overload, highlighting the importance of integrating such strategies into routine hemodialysis care to optimize patient outcomes (Gul et al., 2021).

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e-ISSN: 2985-959X

CONCLUSION

Evaluation of the implementation of ankle pump exercise and foot massage intervention over 3 days showed a decrease in the degree of edema to grade 1, with a depth of 2 mm on the right leg and 1 mm on the left leg. In addition, the size of the leg circumference also decreased to 20 cm at the ankle and 25.5 cm at the instep on the right leg and 19 cm at the ankle and 23.7 cm at the instep on the left leg. There was an increase in muscle strength, initially allowing the left leg to shift and lift by 2 cm to 5 cm and the right leg by 1 cm to 4 cm. Therefore, ankle pump exercise and foot massage therapy can support the reduction of edema in clients with CKD. This study has limitations, as it only reviewed one patient with CKD who received furosemide and hemodialysis therapy. Therefore, there is no comparison of the effectiveness of edema reduction with this intervention in CKD patients. Suggestions for future researchers include comparing the application of ankle pump exercises and foot massage interventions in patients with and without hemodialysis, so that the effectiveness of this intervention can be described more accurately.

ACKNOWLEDGEMENT

The author would like to thank RSD Dr. Soebandi Jember for allowing the implementation of this study and for providing access to the necessary data and facilities. Appreciation is also extended to the patient and family who participated in this case study with full cooperation. Special thanks to the academic and clinical supervisors for their valuable guidance and support throughout the completion of this scientific work.

CONFLICT OF INTEREST

The author declares no conflict of interest in the conduct, preparation, and publication of this study.

REFERENCES

Ahmed, K., Dubey, M. K., Dubey, S., & Pandey, D. K. (2025). Chronic kidney disease: Causes, treatment, management, and future scope. In *Computational Intelligence for Genomics Data* (pp. 99-111). Academic Press. https://doi.org/10.1016/B978-0-443-30080-6.00010-9

Alkhaqani, A. L. (2022). Risk Factors and Complications of Chronic Kidney Disease: Narrative Review. *Al-Rafidain Journal of Medical Sciences, 2,* 107–114. https://doi.org/10.54133/ajms.v2i.68

Alshammari, B., Edison, J. S., Alkubati, S. A., Alrasheeday, A. M., Albagawi, B., Alharbi, L. L., Motakef, H. I., Alshammari, L., Siam, B. G., Alharbi, N. A., Assiri, W., Almoqad, A. A., Aldibas, A. I., & Alshammari, F. (2025). Effectiveness of exercise in reducing symptom burden among hemodialysis patients: A non-pharmacological intervention approach. *Frontiers in Public Health, 13,* 1580689. https://doi.org/10.3389/fpubh.2025.1580689

Ameh, O. I., Ekrikpo, U. E., Bello, A. K., & Okpechi, I. G. (2023). Complications of Haemodialysis. In *Management of Kidney Diseases* (pp. 363-382). Springer International Publishing. https://doi.org/10.1007/978-3-031-09131-5_18

Çeçen, S., & Lafcı, D. (2021). The effect of hand and foot massage on fatigue in hemodialysis patients: A randomized controlled trial. *Complementary Therapies in Clinical Practice, 43,* 101344. https://doi.org/10.1016/j.ctcp.2021.101344

Doan, V., Shoker, A., & Abdelrasoul, A. (2024). Quality of Life of Dialysis Patients: Exploring the Influence of Membrane Hemocompatibility and Dialysis Practices on Psychosocial and Physical Symptoms.

Journal of Composites Science, 8(5), 172. https://doi.org/10.3390/jcs8050172

Gul, H., Fatima, A., Ahmad, A., & Gilani, S. A. (2021). Effects of Ankle Pumping Exercises on Limb Edema in Critically ill Patients with Acute Respiratory Distress Syndrome. *THE THERAPIST (Journal of Therapies & Rehabilitation Sciences),* 15-18. https://doi.org/10.54393/tt.v2i2.26

Gupta, R., Woo, K., & Yi, J. A. (2021). Epidemiology of end-stage kidney disease. *Seminars in Vascular Surgery, 34*(1), 71-78. https://doi.org/10.1053/j.semvascsurg.2021.02.010

Kim, G. H. (2023). Fluid and Electrolyte Problems in Chronic Kidney Disease. In *Management of Chronic Kidney Disease: A Clinician's Guide* (pp. 327-344). Springer International Publishing. https://doi.org/10.1007/978-3-031-42045-0_22

Li, H., Zhang, W., Lu, Q., Wang, J., Zhi, Y., Zhang, L., & Zhou, L. (2022). Which Frequency of Ankle Pump Exercise Should Be Chosen for the Prophylaxis of Deep Vein Thrombosis? *INQUIRY: The Journal of Health Care Organization, Provision, and Financing.* https://doi.org/10.1177_00469580221105989

Lightfoot, C. J., Wilkinson, T. J., & Smith, A. C. (2023). Non-pharmacological management of chronic kidney disease. *Medicine, 51*(3), 170-175. https://doi.org/10.1016/j.mpmed.2022.12.004

Maharem, T. A. S., Shehata, A. M., & Khalil, B. M. (2022). Effect of ankle pump exercise on fatigue sensation, comfort, and lower limb hemodynamics among deep vein thrombosis patients. *International Journal of Health Sciences,* 6(S9), 4945–4957. https://doi.org/10.53730/ijhs.v6nS9.14488

Maurya, N. K. (2025). Navigating Post-Dialysis Challenges: A Review of Common Symptomatology and Clinical Management Approaches. Archives of Clinical and Experimental Pathology, 4(1). https://doi.org/10.31579/2834-8508/041

Reddi, A. S. (2022). Chronic kidney disease. In *Absolute Nephrology Review: An Essential Q & A Study Guide* (pp. 211-270). Springer International Publishing. https://doi.org/10.1007/978-3-030-85958-9_4

Ren, N., Yang, G., Ren, X., & Li, L. (2021). Effects of foot massage on relieving pain, anxiety, and improving the quality of life of patients who have undergone cervical spine surgery. *Health and Quality of Life Outcomes, 19*(1), 22. https://doi.org/10.1186/s12955-021-01667-2

Rias, Y. A., Sofiani, Y., Yunitri, N., Rayasari, F., & Hernani, E. (2024). Effect of combined ankle exercise and self-foot massage on ankle-brachial index and diabetic peripheral neuropathy symptoms. *Riset Informasi Kesehatan, 13*(2), 223-237. https://doi.org/10.30644/rik.v13i2.908

Sahran, S., Nugroho, N., & Annisa, R. (2024). Foot Massage Influences Circulation Fluctuations in the Event of Chronic Failure Edema of the Foot. *Tropical Health and Medical Research, 6*(2), 29–35. https://doi.org/10.35916/thmr.v6i2.119

Sakai, K., Takahira, N., Tsuda, K., & Akamine, A. (2021). Effects of intermittent pneumatic compression on femoral vein peak venous velocity during active ankle exercise. *Journal of Orthopaedic Surgery.* https://doi.org/10.1177/2309499021998105

Smith, B., Park, J., Landi, J. L., McConnell, B., Rahman, A., Omari, A. R., Shahab, Z., Carilli, A., Pearl, K., Kim, B., & Costin, J. M. (2024). Chronic Edema Management of the Lower Extremities. *Cureus, 16*(7), e63840. https://doi.org/10.7759/cureus.63840

Songwathana, P., Akaraborworn, O., Sae-Sia, W., & Choksuchart, C. (2025). Effects of an electronic foot massage device on venous blood flow velocity in healthy adults. *Journal of Vascular Nursing, 43*(2), 80-85. https://doi.org/10.1016/j.jvn.2025.03.001

Young, S. (2021). Chronic Kidney Disease and the Dialysis Patient. In *Preoperative Assessment: A Case-Based Approach* (pp. 167-173). Springer International Publishing. https://doi.org/10.1007/978-3-030-58842-7_26