

# The Effect of a Combination of Foot Exercises and Warm Water Soaks on Improving Peripheral Circulation in Patients with Diabetic Neuropathy

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## ARTICLE INFO

## ABSTRACT

### Article history

Submitted: 30 March 2026

Revised: 18 May 2026

Accepted: 24 May 2026

### Keywords:

Diabetic neuropathy, diabetic foot exercises, warm water foot soak, peripheral circulation, Ankle-Brachial Index (ABI)

Diabetic neuropathy is a common complication of diabetes mellitus that impairs peripheral circulation and increases the risk of foot ulcers and eventual amputation. Non-pharmacological interventions such as diabetic foot exercises and warm water foot soaks have not yet been fully optimized in nursing practice, despite their potential to improve peripheral circulation. This case report aimed to evaluate the effectiveness of combining diabetic foot exercises with warm water foot soaks in enhancing peripheral circulation and reducing blood glucose levels in a patient with diabetic neuropathy. The study employed a descriptive design based on the nursing process, involving a 73-year-old female patient diagnosed with Type 2 Diabetes Mellitus and diabetic neuropathy. The combined intervention consisted of 15–20 minutes of diabetic foot exercises followed by a 15-minute warm water foot soak at a temperature of 37–40°C. The intervention was administered daily for seven consecutive days. Evaluation measures included the Ankle-Brachial Index (ABI) and daily blood glucose monitoring. The results demonstrated an improvement in the ABI value from 0.60 to 1.02, indicating enhanced peripheral circulation, progressing from moderate Peripheral Arterial Disease to a borderline normal category. Blood glucose levels decreased from 381 mg/dL to 189 mg/dL. It should be noted that the patient began taking acarbose 100 mg on the sixth and seventh days, obtained from a community health post (Posyandu). No adverse effects were observed during the intervention period. In conclusion, the combination of diabetic foot exercises and warm water foot soaks improved peripheral circulation and supported glycemic control in a patient with diabetic neuropathy, suggesting that this approach may serve as a safe and practical self-care therapy modality.



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## INTRODUCTION

Diabetes mellitus has become a global health concern, with a growing disease burden worldwide. According to the *International Diabetes Federation* (IDF), approximately 589 million adults are currently living with diabetes, representing 11.1% of the global adult population—equivalent to 1 in 9 adults. This number is projected to rise to 853 million by 2050, with the majority of cases occurring in low- and middle-income countries (IDF, 2025). In Indonesia, the prevalence of diabetes is also high. The 2023 Indonesian Health Survey reported that 11.7% of the population aged 15 years and older have diabetes mellitus, up from 10.9% in 2018. This increasing prevalence places Indonesia fifth in Southeast Asia and highlights diabetes as a significant public health issue at both the national and global levels (IDF, 2025).

Diabetic neuropathy is one of the most common complications in patients with diabetes mellitus, affecting an estimated 50% of individuals with the condition (Zhu *et al.*, 2024). This disorder is characterized by peripheral nerve dysfunction resulting from prolonged hyperglycemia, which may present as reduced sensation, tingling, numbness, pain, and muscle weakness in the lower extremities. Impaired peripheral circulation in diabetic neuropathy is primarily caused by a combination of peripheral nerve damage and vascular angiopathy. Chronic

hyperglycemia damages the structure of small blood vessels and accelerates atherosclerosis in larger arteries, leading to a significant reduction in blood and oxygen supply to the extremities (Antono *et al.*, 2025). Damage to sensory and autonomic nerve fibers further weakens vasodilatory reflexes, substantially reducing blood flow to the feet. The consequences are serious, as diminished sensation combined with poor blood circulation significantly increases the risk of wounds, foot ulcers, and even amputation (Firdaus, 2025). Reduced sensory function is particularly dangerous because patients often fail to recognize early injuries. Moreover, the economic burden of managing diabetes-related complications is substantial, as foot wound care and amputation procedures require considerable healthcare resources. These facts underscore the importance of early detection and timely intervention to prevent severe complications in patients with diabetic neuropathy.

The management of diabetic neuropathy largely focuses on glycemic control and pharmacological therapy, including the administration of hypoglycemic agents and neuropathic analgesics. In clinical practice, diabetes nursing care has traditionally emphasized blood glucose regulation through medication and dietary education. However, independent nursing interventions aimed at improving foot circulation and sensory function are often overlooked. Comprehensive and holistic diabetes care should include simple physical measures that patients can perform at home. In everyday practice, these non-pharmacological interventions have not yet been fully optimized (Juanamasta *et al.*, 2021).

Recent evidence highlights the significant benefits of non-pharmacological interventions such as diabetic foot exercises and warm water foot soaks. Scientifically, these two approaches work through physical and vascular mechanisms to improve peripheral circulation. Diabetic foot exercises involve light motor movements consisting of repeated contractions of the calf and ankle muscles. These movements help facilitate venous return to the heart by enhancing the function of the calf muscle pump. In addition, they contribute to strengthening the foot muscles and preventing deformities (Barangkau *et al.*, 2025). Soaking the feet in warm water at a temperature of 37–40°C induces peripheral capillary vasodilation. The applied heat increases local tissue metabolism and promotes the dilation of blood vessels, thereby enhancing the delivery of blood, oxygen, and nutrients to the nerves in the feet (Ibrahim & Dewi, 2024). As a result, these two interventions can enhance foot nerve sensitivity and help alleviate the symptoms of neuropathy.

Several combined studies have reported a synergistic effect from integrating both interventions. Cahyandari *et al.* (2024) stated that regularly soaking the feet in warm water while performing diabetic foot exercises can improve peripheral circulation, reduce neuropathic symptoms, and help prevent the development of foot ulcers. Research involving older adults with diabetes also demonstrated a significant improvement in foot sensitivity scores after two weeks of combined foot exercise and hydrotherapy intervention (Aryani & Susilowati, 2024). These findings highlight the potential for implementing synergistic, evidence-based nursing care for patients with diabetic neuropathy. However, reports on the integration of diabetic foot exercises and warm water foot soaks in Indonesia remain very limited. Only a small number of studies have examined this combined therapy, and the existing evidence is still insufficient to broadly represent the overall effectiveness of the intervention.

This case report is distinctive in that it demonstrates significant clinical improvement within a short period through a combined non-pharmacological intervention. The improvement in the *Ankle-Brachial Index (ABI)* from moderate *Peripheral Arterial Disease* to a borderline normal category, along with a meaningful reduction in blood glucose levels within seven days, represents outcomes that are rarely reported with conventional therapy alone. In Indonesia, reports on the combined use of diabetic foot exercises and warm water foot soaks with daily parameter monitoring remain limited. Therefore, the findings of this case provide new insights for diabetes nursing practice. This case report underscores a holistic nursing approach, highlighting how simple interventions can produce substantial clinical benefits for patients. Accordingly, this case report aims to evaluate the effectiveness of combining diabetic foot exercises and warm water foot

soaks in improving peripheral circulation and reducing blood glucose levels in patients with diabetic neuropathy.

## **METHOD**

This case report employed a descriptive design based on the nursing process, as it involved a single patient who was assessed comprehensively and received detailed nursing care from initial assessment through evaluation. The primary focus was to describe the patient's clinical problems and the nursing interventions provided in a systematic manner, following the stages of assessment, nursing diagnosis, planning, implementation, and evaluation. The subject of this case report was Mrs. S, a 73-year-old woman whose highest level of education was elementary school. She worked as a traditional massage therapist, was widowed, practiced Islam, and resided in Bunutwetan Village, Pakis District, Malang, Indonesia. The patient had been diagnosed with Type 2 Diabetes Mellitus accompanied by diabetic neuropathy.

The patient was selected purposively based on predefined inclusion criteria: a confirmed diagnosis of Type 2 Diabetes Mellitus with diabetic neuropathy; no history of other medical complications that could interfere with the intervention; intact lower extremities without wounds, ulcers, or deformities; and a cooperative attitude with willingness to complete the entire intervention protocol, as evidenced by written informed consent. Social considerations also influenced the selection process. The patient lived alone without family support, highlighting the need for guidance and assistance during the course of care. This circumstance underscored the importance of promoting independent nursing interventions that the patient could continue at home after receiving appropriate education. Additionally, the patient's home environment was conducive to the daily implementation of diabetic foot exercises and warm water foot soaks in accordance with the study protocol.

Ethical considerations were strictly observed by obtaining written informed consent prior to the implementation of the intervention. The patient's identity was kept confidential through the use of initials in all documentation. All procedures were conducted in accordance with clinical standards and were non-invasive in nature. The patient received a comprehensive explanation regarding the purpose, procedures, potential benefits, and minimal risks associated with the intervention before participation.

A comprehensive assessment was conducted on the first day, including a detailed medical history covering past illness, chief complaints, and current medications. The physical examination included vital signs assessment, peripheral pulse palpation, *Capillary Refill Time (CRT)*, extremity temperature, skin color and integrity, sensory testing using the 10-gram Semmes-Weinstein monofilament, and ankle *Range of Motion (ROM)* evaluation. Blood glucose levels were measured using a glucometer. *The Ankle-Brachial Index (ABI)* was determined by measuring the systolic blood pressure at the dorsalis pedis or posterior tibial artery in the foot and comparing it with the systolic blood pressure at the brachial artery in the arm.

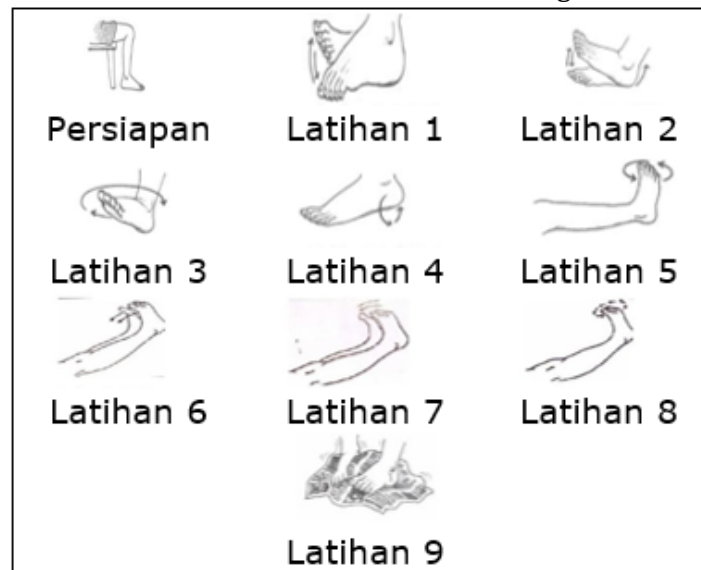
The initial assessment revealed that the patient frequently experienced tingling in both feet, particularly at night, and reported decreased sensation, often failing to notice minor injuries. Physical examination findings showed a blood pressure of 136/90 mmHg, pulse rate of 88 beats per minute, respiratory rate of 20 breaths per minute, and body temperature of 36.5°C. Bilateral dorsalis pedis pulses were weak on palpation, with a *Capillary Refill Time* exceeding three seconds in both feet. The feet felt cooler compared to other parts of the body. Sensory testing using the 10-gram Semmes-Weinstein monofilament indicated reduced sensation at several points on the plantar surfaces of both feet. Ankle Range of Motion was limited, accompanied by mild pain during dorsiflexion and plantarflexion. *The Ankle-Brachial Index (ABI)* value was 0.60, consistent with moderate *Peripheral Arterial Disease (PAD)*, and the random blood glucose level was 381 mg/dL. At the time of the initial assessment, the patient was not taking any medications.

The combined intervention was administered daily for seven consecutive days at the patient's home, following the sequence outlined below:

### 1. Diabetic Foot Exercises

Diabetic foot exercises consist of a structured series of physical movements involving various motions of the feet, characterized by continuous, rhythmic, progressive, and endurance-based patterns. The exercises were performed once daily in the morning, with a duration of 15–20 minutes per session. This method was selected because diabetic foot exercises have been shown to improve peripheral blood circulation in patients with diabetes mellitus.

Before beginning the exercises, the patient was instructed to sit upright on a chair with both feet resting flat on the floor. The movements included the following:



**Figure 1. Diabetic Foot Exercise Movements**

- 1) Exercise 1 (10 repetitions): Curl the toes of both feet into a claw-like position, then straighten them back out
- 2) Exercise 2 (10 repetitions): Lift the forefoot while keeping the heels on the floor, lower the forefoot, then lift the heels and lower them again
- 3) Exercise 3 (10 repetitions): Lift the forefoot and rotate the ankle outward in a full 360° circular motion
- 4) Exercise 4 (10 repetitions): Lift both heels, rotate them outward, lower them back to the floor, and return them to the center position
- 5) Exercise 5 (10 repetitions): Raise one knee, straighten the leg, extend the toes forward, then lower the leg back down. Alternate between the left and right legs
- 6) Exercise 6 (10 repetitions): Straighten one leg along the floor, lift it slightly, flex the toes toward the face, then lower the heel back to the floor
- 7) Exercise 7 (10 repetitions): Lift both legs, straighten and hold the position, then move the ankles forward and backward
- 8) Exercise 8 (10 repetitions): Straighten and lift one leg, then rotate the ankle in circular motions
- 9) Exercise 9: Using both feet, crumple a sheet of newspaper into a ball. Then unfold it again using both feet and tear it into small pieces. Gather the torn pieces with both feet and place them onto another sheet of newspaper. Finally, wrap everything together with both feet to form a ball shape

## 2. Warm Water Foot Soak

A warm water foot soak is a non-pharmacological therapy in which the patient's feet are immersed in warm water to enhance peripheral blood flow, promote vascular relaxation, and reduce stiffness, pain, or sensory disturbances. The procedure was performed once daily after the foot exercises. The equipment used included a basin or foot-soaking container, a water thermometer, clean water, a clean towel, a stable chair, clean gloves, a stopwatch, and a thermal cover to help maintain a stable water temperature. The steps of the foot soak procedure included the following:

- 1) Fill the container with clean water that has been heated to a temperature of 37–40°C
- 2) Use a thermometer to ensure the temperature remains stable, and place a thermal cover in the soaking container to maintain warmth
- 3) Instruct the patient to immerse both feet in the water up to the ankle or lower calf level
- 4) Set the soaking duration to 15 minutes per session
- 5) Monitor the patient throughout the procedure by observing subjective responses (comfort level, sensation of heat, tingling, or pain) and objective signs (changes in skin color, swelling, or any adverse reactions)
- 6) After the session is completed, carefully remove the feet from the water and dry them gently with a clean towel, avoiding vigorous rubbing

Each daily foot care session followed a structured sequence: foot exercises → warm water foot soak → gentle drying of the feet. This order was intentionally designed so that muscle stretching and activation were performed first, followed by vasodilation induced by warm water immersion. The session concluded with proper foot care to maintain hygiene and preserve optimal skin moisture.

Daily evaluation included measurement of the *Ankle-Brachial Index* (ABI), blood glucose levels, adherence to procedural protocols, identification of any contraindications, communication during the intervention, and the patient's overall comfort. ABI measurements were performed each day using a portable Doppler ultrasound device and a digital sphygmomanometer to ensure consistency. Blood glucose levels were also monitored daily using a digital glucometer. Documentation covered all procedures performed, the patient's responses during and after the intervention, recorded parameter measurements, and the condition of the patient's feet. All records were written clearly and legibly, and were signed with the full name of the responsible provider.



Figure 2. Activity Documentation

## RESULTS

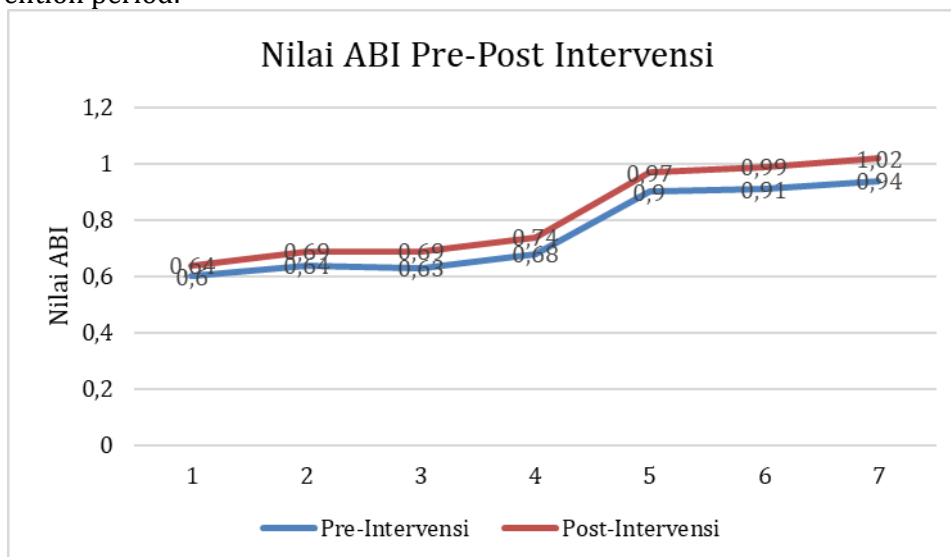
The combined intervention of diabetic foot exercises and warm water foot soaks administered over seven consecutive days to Mrs. S demonstrated significant improvement in both blood glucose levels and *Ankle-Brachial Index* (ABI) values. The daily changes in ABI values and

blood glucose levels observed throughout the intervention period are presented in the following table.

**Table 1. ABI Evaluation Over 7 Days**

Day	Ankle Systolic Pressure (mmHg)		Brachial Systolic Pressure (mmHg)		ABI		ABI Interpretation	Blood Glucose Level (mg/dL)
	Pre	Post	Pre	Post	Pre	Post		
1	53	56	87	87	0,60	0,64	Moderate PAD	381
2	53	57	82	83	0,64	0,69	Moderate PAD	-
3	53	58	84	84	0,63	0,69	Moderate PAD	-
4	56	61	82	82	0,68	0,74	Moderate PAD	-
5	88	95	97	98	0,90	0,97	Normal Borderline	-
6	87	96	97	97	0,91	0,99	Normal Borderline	-
7	51	55	54	54	0,94	1,02	Normal Borderline	189

The figure below presents a comparative graph of the *Ankle-Brachial Index* (ABI) values before (pre) and after (post) the seven-day combined intervention of diabetic foot exercises and warm water foot soaks in a patient with diabetic neuropathy. Measurements were conducted daily to evaluate the progression of peripheral circulation in the patient’s lower extremities throughout the intervention period.



**Figure 3. ABI Evaluation Over 7 Days**

The ABI measurements demonstrated a gradual improvement over the seven days of the combined foot exercise and warm water soak intervention. On the first day, the patient’s ABI was 0.60, indicating moderate Peripheral Arterial Disease (PAD). Following the intervention, the ABI increased to 0.64 on day two, 0.69 on day three, 0.74 on day four, 0.97 on day five, 0.99 on day six, and reached 1.02 on day seven. The shift in ABI values from the moderate PAD category to borderline normal between days five and seven reflects a significant improvement in peripheral circulation of the lower extremities. Ankle systolic pressure showed overall improvement compared to baseline measurements, while brachial systolic pressure remained relatively stable, ranging between 82–97 mmHg throughout the observation period. Another notable finding was the reduction in random blood glucose levels from 381 mg/dL on day one to 189 mg/dL on day seven. It is important to note that on days six and seven, the patient began taking acarbose 100 mg, which likely contributed to the observed decline in blood glucose levels.

## **DISCUSSION**

The results of the combined intervention of diabetic foot exercises and warm water foot soaks in Mrs. S demonstrated an increase in the ABI from 0.60 to 1.02 within seven days, indicating an improvement in lower-extremity peripheral circulation from moderate PAD to a borderline normal category. These findings are consistent with the study by Setyowati *et al.* (2024) which reported an increase in ABI from 0.95 to 1.138 following a diabetic foot exercise program. Similarly, Saputri *et al.* (2025) found that warm water foot soak therapy increased the mean ABI by 0.281 after a single session. Furthermore, Deski & Yendrial (2025) enforced this evidence by demonstrating that a combination of regular walking therapy and warm foot soaks increased the mean ABI from 0.67 to 0.77 in patients with Type 2 Diabetes Mellitus, highlighting the synergistic effect of these interventions in improving peripheral perfusion.

The improvement in peripheral circulation observed in Mrs. S can be explained by complementary mechanisms of thermal vasodilation and muscular activity. Immersing the feet in warm water at 37–40°C stimulates peripheral vasodilation and enhances blood flow to the extremities through the release of endothelial mediators such as nitric oxide (NO). Kurnia & Fitri (2023) reported that warm foot soak therapy triggers NO release, leading to relaxation of the smooth muscle in arterial walls, thereby dilating blood vessels and improving tissue perfusion. Wurangian *et al.* (2019) further noted that local heat stimulation promotes vasodilation, reduces blood viscosity, and increases peripheral capillary permeability, allowing blood to flow more efficiently to foot tissues. Diabetic foot exercises provide a kinetic stimulus that further supports circulatory improvement through contraction of the lower limb muscles, which enhances the muscle pump mechanism and opens previously collapsed muscle capillaries. Muscle activity increases local intravascular pressure and shear stress in peripheral arteries, stimulating endothelial dilation. Together, these mechanisms produce a synergistic effect: vasodilation enhances blood flow, while muscle contractions strengthen the propulsion of that flow. This combined action likely contributed to the significant increase in ABI observed in Mrs. S.

An additional noteworthy finding of this intervention was the reduction in blood glucose levels from 381 mg/dL to 189 mg/dL within seven days. A decrease of more than 190 mg/dL reflects a clinically meaningful improvement in glycemic control. This result is consistent with the study by Ni'mah & Ubaidillah (2025) which reported that a three-day consecutive combination of diabetic foot exercises and warm water foot soaks reduced random blood glucose levels from 360 mg/dL to 240 mg/dL. Similarly, Kurnia & Fitri (2023) documented a decrease in glucose levels from 380 mg/dL to 160 mg/dL after approximately one week of combined therapy. Further demonstrated that regular diabetic foot exercises effectively improve peripheral blood flow while simultaneously lowering blood glucose levels. The mechanism underlying glycemic reduction involves increased muscular glucose utilization and improved insulin sensitivity. Muscle contractions during foot exercises open a greater number of muscle capillaries and enhance glucose uptake by muscle cells, partially independent of insulin action. Warm water foot soaks may contribute by improving glucose distribution to peripheral tissues through vasodilation and by supporting hormonal regulation of glucose via neural and baroreceptor stimulation.

It should be noted that on days six and seven, Mrs. S began taking acarbose 100 mg obtained from a community health post (posyandu). While this medication likely contributed to the decline in blood glucose levels, it was not part of the original intervention protocol.

Throughout the seven-day intervention period, no complications or adverse effects were observed in Mrs. S. The combination of diabetic foot exercises and warm water foot soaks was relatively safe when the water temperature was maintained within the range of 37–40°C and the soaking duration was carefully controlled. These precautions are particularly important to prevent burns in patients with peripheral neuropathy who have reduced pain and temperature perception. Deski & Yendrial (2025) emphasized that this temperature range produces positive physiological effects, such as vasodilation, without increasing the risk of injury when properly

supervised. The safety of this intervention is further supported by the recommendations of the National Diabetes Information Clearinghouse (2005), which advocates cleansing the feet with warm water as part of routine diabetic foot care, without reporting harmful effects.

## **CONCLUSION**

The combination of diabetic foot exercises and warm water foot soaks proved effective in improving peripheral circulation in a patient with diabetic neuropathy, as evidenced by the increase in the Ankle–Brachial Index (ABI) from 0.60 to 1.02 over seven days of intervention. The improvement in peripheral circulation can be explained by the synergistic mechanism between thermal vasodilation induced by foot immersion in warm water at 37–40°C and the muscle pump activity generated through structured foot exercises, both of which enhance blood flow to the lower extremities. This combined intervention also demonstrated a positive impact on glycemic control, reflected in the reduction of blood glucose levels from 381 mg/dL to 189 mg/dL. However, it should be acknowledged that on days six and seven, the patient began taking acarbose 100 mg obtained from a community health post (posyandu), which was not part of the original intervention protocol and may have contributed to the observed glucose reduction. Both non-pharmacological interventions were implemented safely without adverse effects. Therefore, they can be recommended as practical and safe self-care therapy modalities to improve peripheral circulation and support glycemic control in patients with diabetic neuropathy.

## **AUTHOR'S DECLARATION**

### **Authors' contributions and responsibilities**

NEW: Supervision, Review and Editing, Validation (Final Confirmation), Conceptualization and Writing Original Draft Preparation.

AINR: Data Collection, Investigation, Data Curation, Formal Analysis, Visualization, Supporting Draft, Project Administration.

### **Funding**

Personal expenses

### **Availability of data and materials**

All data and supporting materials for this study are available and can be requested directly from the corresponding author.

### **Competing interests**

The authors declare no competing interests.

## **ACKNOWLEDGEMENT**

The authors express their appreciation to all parties who have provided facilities, support, and constructive feedback throughout the preparation of this research. Their contributions have greatly assisted in completing this study to the best possible standard

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